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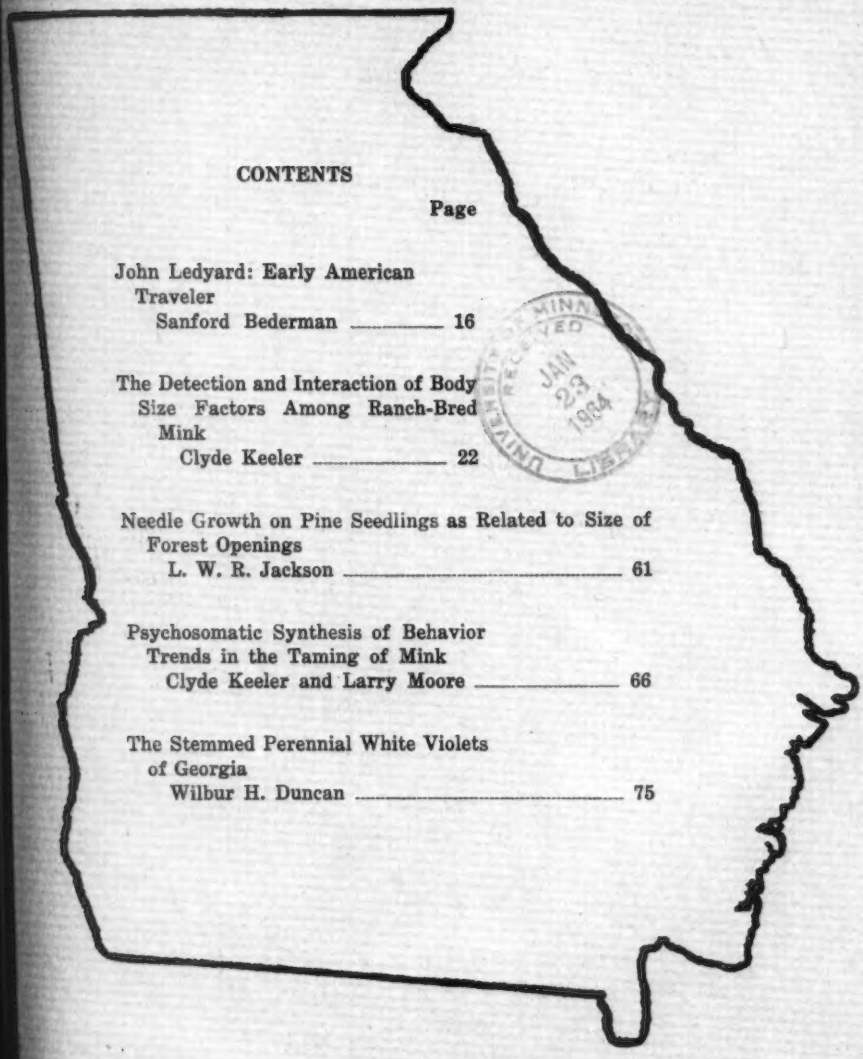
BULLETIN *of*
The GEORGIA ACADEMY *of* SCIENCE

Volume XIX JUNE, 1961 Number 3



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BULLETIN OF
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JOHN LEDYARD: EARLY AMERICAN TRAVELER

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Georgia State College

The history of geography is replete with the names of persons who made their contributions to the discipline, not through strict methodological research, but rather as travelers who wrote about their observations as they wandered over lands and waters little known to the general public of their day.

Their contributions are manifold. Through their written narratives, the Western World first began to learn about the anatomy of the earth and in doing so demolished an untold number of myths, some of which were accepted as truth up to the 19th Century.

Modern geography also has profited by the work of early travelers because their narratives serve as a marvelous source from which we now can relate geographical change. Most geographers today agree that the present-day landscape cannot fully be understood unless past landscapes are properly known. For the most part, the traveler has supplied us the needed information.

Many of the early travelers were a combination of geographer, ethnographer, naturalist, tenacious adventurer, and usually one part superman. When one reads about Orellana in the Amazon, Cabeza de Vaca in North America, Mungo Park in West Africa, or Henry Stanley in the Congo, and considers their hardships, the notion that they had a bit of the superhuman in them is not hard to believe. Surprisingly, even those with a limited formal education had the ability to write coherently about their adventures.

One of these individuals was John Ledyard (1750?-1788), a native of Connecticut who despite his short life probably was the greatest traveler of his time and yet is rarely remembered today for his exploits.

At the age of twenty-two (1772), Ledyard enrolled at Dartmouth College in Hanover, New Hampshire, which at that time trained missionaries to work among the Indians. After four months in school he disappeared. Three and a half months later he returned, telling his classmates that he had been living with the Indians on the Canadian border. His sojourn with the Iroquois caused him to disagree with the purpose for which Dartmouth had been established and he left school. He felt that the Indians did not need missionaries and should be left alone.

In the next sixteen years (until his death), he was to (1) serve with Captain James Cook on his third voyage to the Pacific Ocean and also write the first published account of that voyage;

(2) make an abortive attempt to cross Russia in hopes of reaching the American Northwest; and (3) was to be the first "scientific" explorer sent out by the African Association for Promoting the Discovery of the Interior of Africa which was headed by Sir Joseph Banks, the most noted British scientist of the period, and the leading authority on Africa.

Ledyard in the Pacific (1776-1780)

Ledyard joined Captain Cook's group as a corporal of marines, having as his main responsibility the protection of astronomical and navigational equipment which was put ashore each time the position of an island was to be fixed. Despite his low rank, his name is mentioned several times by historians of the voyage. James Burney, one of Cook's officers and also a noted historian, stated in his book that "Ledyard had the most romantic enthusiasm for adventure perhaps of any man of his time." Andrew Kippis, the first historian of Captain Cook's voyages, discussed Ledyard for his part in establishing the first communication with Russian fur traders at Unalaska in the Aleutians.

Ledyard's own book, *A Journal of Captain Cook's Last Voyage to the Pacific Ocean* (Hartford, 1783), is a remarkable work because it was written from memory. Even so, his observations have been corroborated by official journals published later. In this book, as well as in his numerous correspondences, one finds a keen observing mind at work. This is especially true of the sections on the ethnography of the various peoples he encountered. He did more than merely describe what he saw, for he was quite willing to interject hypotheses as possible explanations for the reality he witnessed. For example, after a detailed ethnographic description of the Tahitians, he hypothesized about their origins. He perceptively pointed out the two possibilities (Asiatic and South American), which are still under conjecture today. Even though he argued both sides, there is little doubt that he believed the Polynesians had Asiatic origins.

When Cook landed at Nootka Sound in March, 1778, Ledyard was given another opportunity to observe the American Indian. He began immediately to compare the Nootka with the Iroquois. This short visit in the American Northwest was to obsess his thinking for the remainder of his life. Ledyard noted that the Nootka used several implements that must have been acquired through trade with other tribes as far east as Hudson Bay. If trade items could find their way across the continent, going from tribe to tribe, he could do it also, even though no white man before him had ever crossed the wide expanse.

He concluded also that there was much room for expanding the fur trade in the American Northwest, as the only others operating there were the Russians. When Cook's vessels stopped in Canton, China on the way home from the Arctic and Kam-

chatka, Ledyard saw pelts there from North America selling for almost three times as much as they did farther north in Kamchatka, and this further whetted his desire to attempt starting his own fur trade.

Ledyard in Russia (1786-1788)

In the six years (1780-1786) after Cook's third voyage, Ledyard made many futile attempts to gain financial backing for his venture to the Pacific Northwest. He lived in France most of the time, where he formed a short-lived business partnership with John Paul Jones, and also became a close friend of Thomas Jefferson, then the United States ambassador to France. Ledyard often spoke with Jefferson about his plans and actually worked out details for exploring the North American continent from west to east. Thus in all probability, he planted the seed that matured in the Lewis and Clark expedition twenty years later when Jefferson was president. Jefferson had suggested that Ledyard should travel to his destination via St. Petersburg and Kamchatka, and after plans for ocean travel to the Pacific Northwest failed because of lack of funds, Ledyard agreed to make the journey across Russia.

He arrived in St. Petersburg in March, 1787, after four months of trekking through northern Scandinavia. His original notion was to cross the frozen Gulf of Bothnia, but it was not frozen solid, so he was forced to move northwards around the Gulf. In May, 1787, he receive permission from Catherine the Great to travel to Kamchatka, and he began his trip under the guise of a naturalist.

As far as Ledyard was concerned, the vast expanse of Russia was nothing more than a large geographical barrier. Jared Sparks, Ledyard's first biographer, stated, "He was impelled forward by a single motive, and he would have gladly annihilated space and time, if he could have set his foot the next moment on the American continent . . ."

By August, 1787, he had reached Irkutsk, and he then moved on to Yakutsk on the Lena River. He had every intention of traveling non-stop to Kamchatka, but was persuaded to spend the winter back in Irkutsk. It was in this portion of his trip that he had time to make a few inquiries about the people and to travel locally in the area.

His observations were kept in a journal which is a curious document. As it was not kept daily, and was never reorganized, it therefore reads as a wandering disconnected narrative discussing such things as the comparison of the racial type of the Tatars and the American Indians; a description of the landscape between Irkutsk and Lake Baikal; a discussion of the shamanistic religion of the native Siberians; a eulogy on women; and a

lengthy description of his impressions of Poland and particularly the Jewish inhabitants of that area.

In January, 1788, he was arrested by the Queen's soldiers and in the dead of winter was transported almost non-stop from Irkutsk to the Polish border where he was deported as a spy. The constant travel, the Russian winter, and the realization that he would not complete his journey, all took their toll on his physical and mental health.

Ledyard and the African Association (1788)

A few months after his banishment from Russia, Ledyard arrived in London (June, 1788) following what he described as a "miserable journey in a miserable country, in a miserable season, in miserable health, and a miserable purse, and disappointed of my darling enterprise." Almost immediately he was offered employment by Sir Joseph Banks, now head of the newly organized African Association. Prior to 1778, exploration in Africa was carried on in a haphazard manner. Many journeys had been made into the interior of Africa before that time, but when the African Association was founded the systematic exploration of that continent began.

By August, 1788, Ledyard was in Cairo, Egypt, with orders to explore the region between the Nile River and the Atlantic Ocean and to determine the true course of Niger River and to visit the city of Timbuctu. Ledyard was the first of many to receive the same instructions, and one of many to fail, for it was to be thirty-eights years (1826) before a European entered Timbuctu and forty-two years (1830) before the mouth of the Niger River was finally discovered.

Ledyard never left Cairo, for he contracted a "bilious complaint," and died in December, 1788. Several of his letters written from Cairo prior to his death indicate that he was actively engaged in gathering information before he was to depart. He was a frequent visitor to the slave markets where he interviewed both owners and slaves concerning conditions along his proposed route.

Ledyard's Contributions

John Ledyard was probably the most widely traveled man of his time. Briefly, his accomplishments were:

1. He was the only American on Cook's third voyage to the Pacific Ocean.
2. On this trip, he was the first person to make contact with the Russians in the Aleutians.
3. His book was the first published concerning the voyage.
4. He was the first man to be employed to conduct scientific

exploration in Africa.

5. His notion to explore North America from ocean to ocean almost certainly influenced Thomas Jefferson, who later commissioned Lewis and Clark to complete the task.

In many ways, his writings are naive and unpolished, but in places he shows sophisticated prescience, especially in his ethnographical descriptions and theories. His ideas on the origin of the Polynesians have been shown valid in our time, as have his notions on the racial relationship of the Tatar, Chinese, and American Indian. His thoughts on cultural diffusion antedate by over a hundred years those of the well known English and German diffusionists.

Ledyard's wide travel in the late Eighteenth Century allowed him a rare opportunity for that time to observe phenomena in many different settings, and thus he was able to say things previously unheard of by his less traveled contemporaries. Many who knew him personally thought him to be a crackpot. There is no doubt that his eccentricities deterred him from accomplishing all he set out to do, but in his attempts he arrived at theories and made statements which today are generally accepted as fact.

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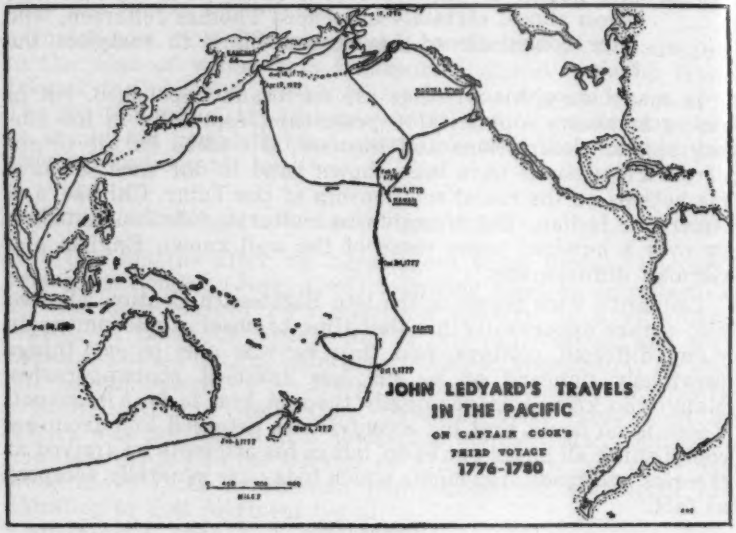
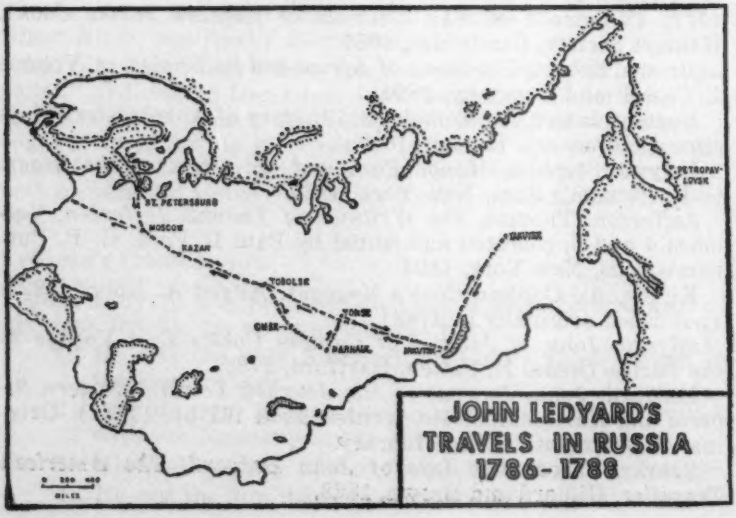

JOHN LEDYARD'S TRAVELS
IN THE PACIFIC
ON CAPTAIN COOK'S
THIRD VOYAGE
1776-1780


ST. PETERSBURG
MOSCOW
KAZAN
TOBOLSK
OMSK
BARNAUL
IRKUTSK
YAKUTSK
PETROPAV-
LOVSK
JOHN LEDYARD'S
TRAVELS IN RUSSIA
1786-1788

THE DETECTION AND INTERACTION OF BODY SIZE FACTORS AMONG RANCH-BRED MINK

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Introduction

It is well known that when members of large sized races of mammals are crossed with representatives of small sized races, the genetic basis for their differences ordinarily turns out to be dependent upon multiple factors. This was the interpretation given by Castle[2] to his classical, long time study of a cross between English giant and Polish dwarf rabbits. However, if Castle's published material is reexamined,[1,2] one finds a suggestion that all the recessive color mutation classes are actually accompanied by a slightly smaller size than normal. The dominant English spotting pattern is also accompanied by a trend to small body size as compared with its recessive, normal allele. Thus, the color mutations seem to be associated with definite size trends that account for a small amount, but not nearly all, of the multiple-factor differences observed between large and small races. It would appear, then, that a number of other size factors must be involved having no visible correlates in color or other known variations, and for this reason such factors cannot be separated for individual examination.

Presumably, Feldman[4] was the first person to study thoroughly a simple coat color with respect to its associated influences on body size. He found the chocolate pigment variation of the house mouse to be associated with a trend toward larger than average body weight. However, Feldman's paper was not printed until after Green[5], who knew of Feldman's findings, had published conclusive evidence on the same phenomenon associated with chocolate and other genes. Because Castle had not recognized the slight correlations existing between color and size inherent in his rabbit material, Green's findings came as a surprise to him. For this reason Castle and his students, Gates, Reed, and Law, undertook a mouse cross that demonstrated chocolate and other coat color genes to be accompanied by size alteration tendencies, much as Green had described.

At that time it was customary, in interpreting these findings, to believe that the coat color gene was linked with a gene for altered size, rather than that both a color and a size tendency were due to manifestations of the same mutant gene. Castle was for a long time adamant in the then current view.

Various persons, including the present author, then noted (much of the data unpublished) that short-eared mice tend to

be small, blue mice tend to be large, wavy mice tend to be small, pink-eyed mice tend to be large, waltzers tend to be small, etc. Some of these trends were so consistent that, because of the wide distribution of mouse stocks, one might suppose that if the mutant gene for a coat color alteration were linked to a gene for body size alteration, cross-overs would have undoubtedly been discovered, and laboratory strains of visible mutants would have been established bearing normal or even opposite trends in size. But this did not happen. The work of Grüneberg[6] on the gray lethal mouse and the findings of others led to a general acceptance of the idea of pleiotropy or multiple manifestations of the same gene allel. However, as late as 1948, many persons at the International Congress of Genetics became skeptical of pleiotropy because of a story that circulated to the effect that a certain highly reputable researcher had proven mathematically that a gene could give rise to one reaction only. Under this restriction, any association between size and color must be due to linkage and not to pleiotropy.

In 1947 the present author[7], upon analyzing the data accumulated by Dr. Henry Donaldson on mutants of the Norway rat, found body length increaser effects associated with chocolate and curly, but body legnth decreaser effects with hooded, albino, ruby eye and waltzer. He shower further[8,9,10] that the decreaser effects associated with ruby eye and hooded tend to cancel the increaser effect of curly in both sexes. Similar effects were detected when body weights of these mutants were compared[11], there being a high correlation between body weight and body length.

The idea was then conceived that because rabbits, rats, and mice represent rodent or rodent-like types, some carnivore newly brought in from the wild should be studied, not only to gather data of greater significance statistically, but also to test the application of these findings to mammals in general. The mutations in such a carnivore group should be followed with regard to size trends over a long period of years from the time the first mutant individual had appeared in order to see if the associated size trends would change.

Combinations of coat colors should be studied carefully to learn (1) if the plus trends are additive and produce very large individuals, (2) if minus trends are additive in the minus direction to produce very small individuals, and (3) if the combination of a plus trend and a minus trend tend to cancel each other out to form average-sized individuals.

It was recognized that certain disadvantages were inherent in the study of carnivores, namely, (1) the high cost of their laboratory production in the great numbers required and (2) the medical care necessary. However, if these animals had a high commercial value, they could be produced in quantity on

ranches, fed a uniform diet, and be cared for through standard procedures, although the research would be limited to examining genetic combinations prepared in anticipation of their marketability.

Ranch-bred foxes were ruled out as experimental animals because of their restricted numbers, although their large size was in their favor.

The ideal animal for these studies has been found to be ranch-bred mink. Mink have been brought in from the wild in fairly recent years and are not yet tame. They are being raised in such great numbers that not a few color phase mutations are cropping out, as might be expected. However, ranches do not ordinarily keep a permanent record of the exact day of birth for each individual mink in the classification register, and birth can take place within a period of about six weeks. This disadvantage is not so bad as it might seem because at pelting time the animals have received almost all of their growth, even though they may be killed within a period of several weeks on very large ranches. Statistically, factors which favor variability are offset to a considerable degree by the large numbers of individuals included in many of the expanded annual populations and their subpopulations of identical genetic background.

Cooperation of the Larry Moore Mink Ranch, located at Suamico, Wisconsin, was obtained, and studies were made on suitable individuals from twelve consecutive annual populations (from 1946 to 1957 inclusive), having a grand total of some 108,717 individuals. This ranch has kept excellent records ever since its founding, and pedigrees have been recorded for all animals.

In order to test whether or not size factors and coat color genes are linked rather than both being pleiotropic manifestations, one should observe the coat colors and sizes over a long period of years. If linked, the size deviation from normal should occasionally separate from the coat color, due to crossing over, but if it is a pleiotropic manifestation of the same gene that produced the coat color, then the same size alteration should forever accompany the color, as mentioned above.

As a development procedure at the Larry Moore Mink Ranch, it was customary to bring in new mutants, in order (1) to cross them to a vigorous, standard Dark strain in order to increase stamina, and then (2) to segregate enough of the new mutants from such a cross to test the value of the new coat color as a market type. The mutants recovered from the cross to standard Dark mink were also (3) combined with other color mutations of proven commercial worth in order to test the color effect of the new mutation in combination with other colorphase types. Thus, the animals included in this study consisted of coat color mutants and combinations of color mutants placed on a relatively

uniform, standard Dark, residual, hereditary background. There were standard Dark mink available with which to compare the study animals.

Because of the variations introduced by commercial production procedures, it would not be supposed that perfect correspondence would be found for all comparisons of the same mutant or combination of mutants. However, one might expect (1) statistical significance in some cases, as well as (2) trends of unproven significance in the same direction.

In the early years of the present study, the investigators dealt mainly with single mutations and their size tendencies as compared with the normal Dark mink strain. However, in the later years many combinations of mutant color genes were produced, giving an opportunity to compare the interactions of various genes with respect to their size effects.

METHOD

Prior to pelting, all animals were classified as to phenotypic appearance and at the time of pelting they were weighed in pounds and tenths of pounds.

Those animals which came from similar matings were recorded in the register in a separate section, together with the individual genetic description and record numbers of their parents in order that pedigrees could be traced. The weight of each individual was recorded. This procedure facilitated selection of new breeding stock each year and provided data from which to gauge the effectiveness of annual selection for larger body size.

This study consisted of collecting into statistical populations the weights of mink of a particular phenotypic constitution. The mean of this color class was determined, together with standard deviation and standard error of the mean. Means of the many combinations produced were compared by routine statistical procedure. Of course, males could only be compared with males, and females with females because of the influence of sex on size. All comparisons had to be made within the same year due to selection for body size and environmental influences, such as variations in food, weather, and slight epidemics. Early and late comparisons are listed in the appendix and are referred to by numbers.

Wherever possible, animals heterozygous for certain recessive coat color genes were not classified together with ones lacking that gene entirely. However, it will be recognized that in segregating populations, heterozygosity for most of the genes studied cannot be distinguished from absence and, as we shall demonstate, significant results may be obtained in many populations in spite of this added factor of variability.

RESULTS

Early Comparisons

In the early years of this study, when Pastel, Breath of Spring, and Silverblu were the most important colorphases on the market, attention was confined mainly to comparing the sizes of animals of these colors with Dark mink. A series of these comparisons is given in the appendix under the title, Early Comparisons.

Without going into detail about all of these, we find that Silverblu tends to be larger than Dark in males:

Appendix No.	*year*	*dm**	*s*	*increase*
(1)	1946	.17	4.0	5.1%

Silverblu females are also larger than Dark females:

Appendix No.	*year*	*dm*	*s*	*decrease*
(9)	1946	.18	11.2	8.6%

Breath of Spring males are smaller than normal Dark:

Appendix No.	*year*	*dm*	*s*	*decrease*
(18)	1946	.13	2.5	4.2%

This is also true for Breath of Spring vs. Dark comparisons for females.

Appendix No.	*year*	*dm*	*s*	*decrease*
(22)	1946	.15	6.5	7.8%

In 1946 the increase in size of Silverblu was compared with the decrease in size accompanying Breath of Spring. In both males and females, these opposite effects tended to cancel each other.

In 1946 Silverblu males were larger than Dark by 5.1%, but Breath of Spring-Silverblu males were 4.3% larger, as shown in in comparison in the Appendix No. (25).

In 1946 Silverblu females were larger than Dark by 8.6%, but Breath of Spring-Silverblu females were 3.5% larger than Dark, as shown in the comparison in the Appendix No. (31).

Black Cross was a white-spotting gene mutation that proved not so popular as some of the other colorphase types, and hence was discontinued after several years. However, during the time that it was under observation, it was definitely proven to be due to a size reducer gene.

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* dm is difference between means. s is significance which represents the difference between means divided by the standard error of the difference between means.

Appendix No.	*year*	*dm*	*s*	*decrease*
males (37)	1946	.16	4.2	5.1%
males (38)	1947	.22	3.05	6.4%
females (39)	1946	.16	7.3	8.9%
females (40)	1947	.15	4.54	7.2%

Much the same story is told by data collected during the next six years, so details of this period are not included here. Discussion of data resumes with those for the annual crop of 1954. By this time several new colorphase genes had been crossed to standard Dark and then extracted again in F2. In addition, numerous combinations were available for a study of the interactions between the size effects of colorphase genes.

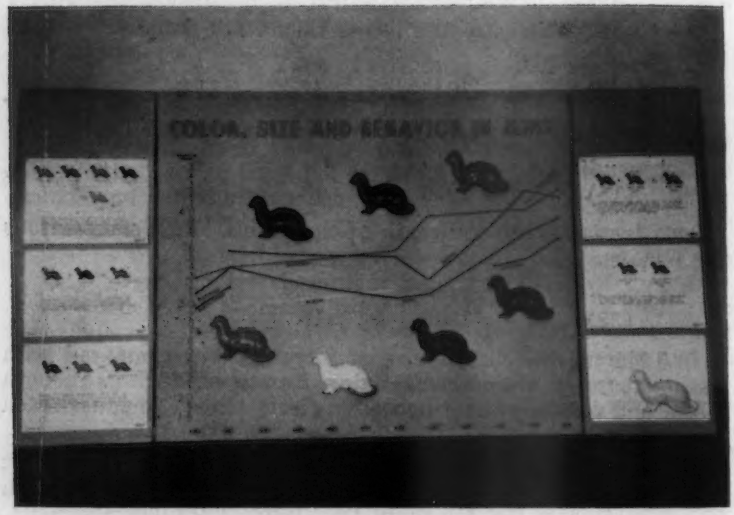

CHART 1. *Chart exhibited at International Congress of Genetics, Montreal, 1958, showing the effectiveness of general selection of unidentified multiple factors for body size in this population for the twelve year period studied. The points on the chart represent actual mean weights of annual populations in pounds and tenths of pounds for the years indicated. On the side wings are shown certain cases of gene interaction affecting body size.*

Later Comparisons

Although about twenty mutations were processed during the time of this study, most of them were soon eliminated as not having market possibilities. Of those remaining, the most important were Silverblu, Pastel, Aleutian, Breath of Spring (Blufrost), Ambergold, Palomino, and Moyle Buff. A small amount

of data was available on Albino which represents really a pigment level in the albino series corresponding to Siamese of the cat and Himalayan of the rabbit. It is of academic interest because in addition to pink eyes, it possesses sooty nose, ears, feet, and tail. When compared to black-eyed white, it is seen to have a small amount of yellow in the body coat.

During the twelve years covered by these observations, selection for larger size was practiced in choosing breeders to produce the annual expanded populations. Consequently, as shown in Chart No. 1, the body size increased rather constantly with chance fluctuations, as might be expected. Unfortunately, the greatest deviation from this gradual increase in size was in the normal Dark control strain where one serious mistake in selection was made. This resulted from finding in the breeding stock a male of such superb vigor, conformation, and fur qualities that it was assumed that his "smaller than the best" size was due to having been born a runt and then having suffered from the natural competition with his litter mates. Unfortunately, after he had been bred into most of the normal Dark stock, his "smaller than the best" size turned out to be genetic, and this fact lowered the average body size of the control stock. The situation was gradually remedied by eliminating the blood of this individual animal from the breeding list and by rigorous selection. Fortunately, the deviation of the control stock for several years from what would be desired was not enough to invalidate most of the comparisons, and had the normal Dark control been rendered useless, comparisons between the mutant populations would still have maintained their significance.

It may be argued that a mutant gene produces a distribution of variates about a mean lying at a particular distance from the mean of the normal distribution. For this reason some of the sample populations bearing this gene will lie so close to the normal mean that the distance to the mutant means will be of unproven statistical significance. It follows that in calculating the approximate position of the mutant mean relative to the position of the normal mean, one should include the mutant populations so close to the normal mean as to be of unproven statistical difference, as well as those of proven statistical difference from the mean of the normal population. Otherwise, if one includes only those populations of statistically proven distance, one will arrive at a collective estimate of the position of the mutant mean farther away from the normal mean than it actually is. Hence in the charts of this study, except for questionable populations of very few variates or of extremely low significance, all populations have been included.

Silverblu

Silverblu animals tend to be larger than normal Dark. There are five male comparisons that illustrate this point.

Appendix No.	*year*	*dm*	*s*	*increase*
(3)	1954	.02	—	0.52%
(4)	1955	.23	2.93	4.68%
(5)	1956	.51	2.88	14.45%
(6)	1956	.29	1.42	7.73%
(7)	1957	.32	3.43	8.12%

In the tables, as in the appendix, dm = difference between means (in pounds) of the two populations compared, and s = significance or difference between means divided by the standard error of the difference between the two means.

The 1954 data, although tending in the same direction as the other comparisons, show very little difference between means. It may be even questionable to include this item because of possible interaction between Silverblu and Moyle Buff involved in the comparison, so it will be omitted from consideration.

Of importance, however, is the fact that the average increase in size of Silverblu is 8.74% above normal Dark, taken in each case as 100%.

Silverblu female comparisons are as follows:

Appendix No.	*year*	*dm*	*s*	*increase*
(15)	1954	.13	2.56	6.53%
(16)	1955	.24	6.78	12.56%
(18)	1955	.13	4.26	7.80%

The Silverblu females exceed the Dark females by an amount quite similar percentage wise, to the males. The average percentage increase is 8.96.

As will be seen later on, Aleutian tends to be smaller than Dark and hence it is not surprising to find in comparison (Appendix, No. 1) that Silverblu Males are significantly larger than Aleutians. In fact, Silverblu males are 5.77% larger than Aleutians in this case.

Appendix No.	*year*	*dm*	*s*	*increase*
(11)	1954	.12	2.15	5.77%
(12)	1954	.04	1.96	——
(19)	1955	.16	1.56	7.80%
(21)	1956	.03	1.39	1.50%

Female comparisons are not so satisfactory as male comparisons. Comparisons No. (11) and (19) show about 6.78% difference. Comparison No. (11) is statistically significant, but Nos.

(19) and (21), though in the right direction, still lack statistical significance. Comparison No. (12) is in the wrong direction and lacks statistical significance.

There is one comparison, No. (2), which tests the effect of Silverblu on Breath of Spring-Aleutian. For this comparison dm is only .06. The populations compared consisted of 422 Silverblu-Breath of Spring-Aleutians and 115 Breath of Spring-Aleutians, but the s is 1.57 and hence not of proven significance.

There are two female comparisons, Nos. (14) and (20), testing the effect of Silverblu on Breath of Spring-Aleutian. For comparison No. (14) the Breath of Spring-Aleutian population has a mean actually larger than the Silverblu-Breath of Spring-Aleutian, but the difference is of practically no significance.

However, for comparison No. (20) the Silverblu-Breath of Spring-Aleutians exceed the Breath of Spring-Aleutians with a dm of .11 and a significance of 2.92. The difference actually represents about 5.53%.

Silverblu was compared with Pastel in No. (8) and in No. (13). In the first comparison Silverblu exceeded Pastel by .12 pounds, with a significance of 2.10. In the other case the dm was only .04, and this difference had practically no significance.

There is one comparison of Silverblu-Ambergold females with Dark, No. (17). In this case the dm is .11 pounds, and the significance is 3.66.

The interaction between Silverblu and Aleutian in males is tested in (9), but the result did not differ from Silverblu in this comparison.

Two comparisons that show the reducing effect of Aleutian upon Silverblu are Nos. (36) and (37).

Appendix No.	*year*	*dm*	*s*	*decrease*
(36)	1954	.16	2.88	7.27%
(37)	1954	.08	1.79	3.77%

Comparison No. (36) shows a significant reduction and No. (37) a lesser reduction, but even this approaches significance. The average percentage difference is 5.52.

The interaction between Breath of Spring and Silverblu was tested in No. (10). The dm is .08 and the significance is 1.1, suggesting a reducing tendency of Breath of Spring.

When Silverblu is combined with Moyle Buff, No. (22), the combination was larger than Moyle Buff alone. The dm was .06 and the s of 1.76 approached significance.

Thus, for Silverblu a tendency to greater size than Dark in both males and females may be confirmed, and an increase of about 5.52%. Silverblu is definitely larger than Aleutian in No. (11) and possibly in Nos. (19) and (21). The increase overcomes Aleutian decrease in No. (1). Silverblu increase is can-

celled completely in No. (14) and partially in Nos. (2) and (10). Only in No. (20) is Silverblu able to significantly overcome the reducing combination of Breath of Spring and Aleutian in females. In No. (22) there appeared to be a tendency for the increaser effects of Silverblu and Moyle Buff females to be additive. Silverblu was significantly larger than Pastel among females in one case, No. (8).

Aleutian

More comparisons are available for Aleutian males than for Silverblu males. Comparisons of Aleutian with Dark are as follows:

Appendix No.	*year*	*dm*	*s*	*decrease*
(28)	1955	.14	.07	3.94%
(29)	1955	.14	1.62	3.94%
(30)	1955	.19	2.12	2.12%
(31)	1955	.27	3.02	7.34%
(32)	1956	.26	1.80	6.93%
(33)	1956	.04	0.42	1.13%

In each case Aleutian males are smaller than Dark males. The comparison, No. (33), may not be quite justified because of the miscellaneous nature of the Dark group. Several of the comparisons, Nos. (30) and (31), are definitely significant, and two others, Nos. (29) and (32), approach significance. The average percent of reduction is 4.23.

There are two comparisons of Aleutian females with Dark females.

Appendix No.	*year*	*dm*	*s*	*decrease*
(38)	1954	.09	2.83	4.52%
(40)	1955	.08	1.89	3.76%

One of these comparisons, No. (38), shows Aleutians to be significantly smaller than their controls. The other, No. (40), shows a reduction in the Aleutians approaching the point of twice the standard error of the difference, actually 1.89. Their average percentage reduction is 4.14.

The effect of Aleutian on the Silverblu-Ambergold combination is definite. Male comparisons are as follows:

Appendix No.	*year*	*dm*	*s*	*decrease*
(34)	1956	.25	4.47	7.42%
(35)	1957	.37	7.90	10.14%

The average percentage reduction is 8.78.

Aleutian cancels the increase effect of Silverblu in two out of three comparisons.

Appendix No.	*year*	*dm*	*s*	*decrease*
(25)	1954	.18	3.61	5.20%
(26)	1954	.07	1.00	2.09%
(27)	1955	.43	7.40	12.83%

The average reduction of the two having significance is 9.01%.

Among females comparison No. (43) was obtained between Aleutian-Silverblu and Ambergold-Silverblu. Aleutian-Silverblu are larger. The dm is .10, the significance is 4.85. This may mean that Silverblu has more effect in combination with Aleutian than with Ambergold. However, comparison No. (41) shows that Aleutian added to Silverblu-Breath of Spring may produce animals of about the same size as when Ambergold is added to Silverblu-Breath of Spring. The dm is .01, the significance 0.15.

Aleutian definitely reduces the Breath of Spring-Silverblu combination.

Appendix No.	*year*	*dm*	*s*	*decrease*
(23)	1954	.24	3.5	7.45%

Aleutian has a greater reducing effect upon the Breath of Spring-Silverblu combination than has Palomino.

Appendix No.	*year*	*dm*	*s*	*decrease*
(24)	1954	.14	3.6	4.55%

When Aleutian is added to Moyle Buff in females, it significantly reduces size, according to comparison No. (42). The dm is .12, the significance is 2.64, and the body size reduction is 5.58%.

There is a comparison, No. (39), in which Silverblu females hybrid for Aleutian are found to be larger than Silverblu hybrid for Ambergold. The dm is .08, and the significance is 1.16. This is suggestive but not to be taken too seriously.

Pastel

There are a number of comparisons of Pastel (chocolate) males with Dark males and several for females.

Appendix No.	*year*	*dm*	*s*	*increase*
		Males		
(46)	1955	.29	3.68	8.17%
(47)	1955	.36	4.84	10.41%
(48)	1955	.14	1.71	3.80%
(49)	1956	.50	3.50	13.33%
(50)	1956	.45	4.40	12.75%
(51)	1957	.23	2.17	5.84%
		Females		
(52)	1954	.09	2.75	4.52%
(53)	1956	.12	6.31	5.55%

Of these eight comparisons all but No. (48) are of significance, and No. (48) approaches significance, showing the size increasing tendency of the Pastel gene. The average percentage increase for males is 9.05, and for females is 5.03.

There are two comparisons of Pastel females with Dark.

Appendix No.	*year*	*dm*	*s*	*increase*
(52)	1954	.09	2.75	4.52%
(53)	1956	.12	6.31	5.55%

Thus, Pastel females are also significantly larger than Dark females. The average increase is 5.03%.

Pastel may be manifested to a certain extent in hybrids as indicated by comparison No. (55). The dm is .15, the significance is 3.02, and the increase is 6.94%.

When Pastel, combined with Breath of Spring, is compared with Aleutian combined with Breath of Spring, the former are significantly larger, as shown in No. (54), in which the dm is .15, the significance is 3.06, and the percentage difference is 6.84.

There is a comparison, No. (45), of the effect of Pastel on Breath of Spring. The dm is .24 and the significance is 4.21. However, the direction is wrong, possibly meaning that the Pastel-Breath of Spring is a relatively weak combination.

When Pastel-Breath of Spring males were compared with Silverblu-Breath of Spring, Pastel developing males exceeded those containing Silverblu by a dm of .12 and a significance of 1.51.

Breath of Spring

The reducing effect of Breath of Spring may be demonstrated by many comparisons. When Breath of Spring males were compared with Pastel, No. (64), the former were found to be smaller by a dm of .23 and a significance of 6.81.

There are two comparisons showing the effect of Breath of Spring on Pastel.

Appendix No.	*year*	*dm*	*s*	*decrease*
(59)	1954	.21	3.1	5.86%
(60)	1955	.02	0.28	0.52%

Comparison No. (59) shows a significant reduction because of Breath of Spring, but No. (60) is of no value, possibly because of the few animals, 48 in number, composing the Breath of Spring-Pastel population.

When combined with Aleutian, Breath of Spring may tend to decrease the size still further, according to No. (56). The dm is .05, and the significance is not proven, being 1.1.

Among 1954 females, comparison No. (67), Breath of Spring added to Aleutian reduced the mean .06 pounds below the Aleu-

tian mean. The significance is 1.99 and hence almost satisfactory. The decrease is 2.88%.

A similar test on 1955 females, comparison No. (68), gave a dm of .06 and a significance of 1.61, which approaches the 2.00 point considered as satisfactory.

A test of the effect of Breath of Spring on Pastel in 1955 gave a dm of .06 and an almost satisfactory significance of 1.87.

A second test on 1956 females was not satisfactory, as shown in comparison No. (72). The dm is .01, and the significance only 0.30.

Among 1954 females, comparison No. (66), there was revealed no significant reduction of Pastel by adding Breath of Spring. However, in two of the three cases just described, the Breath of Spring Pastel is smaller than the Pastel. When combined with Silverblu, comparison No. (58), it reduces size significantly. The dm is .11, the significance is 2.14. There is one comparison, No. (62), in which populations of only 23 and 19 animals were used, and the comparisons cannot be trusted. There was no significant difference between the means, and the Breath of Spring-Silverblus were actually a trifle larger than the Breath of Spring.

There are two male comparisons, Nos. (57) and (61), in which the effect of adding Breath of Spring to Silverblu-Aleutian is tested.

Appendix No.	*year*	*dm*	*s*	*decrease*
(57)	1954	.06	2.00	1.83%
(61)	1955	.05	0.72	1.41%

In No. (57) Breath of Spring significantly reduces the size of Silverblu-Aleutian, and in No. (61) the *dm* is similar, but there are not sufficient animals in the populations compared to provide statistical significance. (The Silverblu-Aleutian population contained only 13 animals.)

There are three comparisons testing the effect in females of Breath of Spring on the Silverblu-Aleutian combination.

Appendix No.	*year*	*dm*	*s*	*decrease*
(65)	1954	.03	1.55	1.47%
(69)	1955	.11	3.47	4.98%
(73)	1956	.10	2.67	5.00%

In two cases the presence of Breath of Spring reduces size with satisfactory significance. The average percentage reduction is 3.81.

Ambergold

Satisfactory Dark controls with which to compare Ambergold are not available. However, its effects on other gene mutations

and certain combinations of mutations can be determined.

In comparison No. (75) it seems possible, but not proven, that Ambergold reduces size when present in the hybrid. The reduction is .09, but the significance is only 0.97.

The reducing effect of homozygous Ambergold on Silverblu may be demonstrated by the following comparisons.

Appendix No.	*year*	*dm*	*s*	*decrease*
(74)	1956	.42	2.82	10.40%
(77)	1957	.50	7.21	11.74%

It will be noted that these reductions are quite significant.

There is another comparison of interest in this connection, namely No. (81). Ambergold-Silverblu is compared with Silverblu-hybrid for Ambergold. The hybridity for Ambergold seems to have reduced the body size of Silverblu (as suggested above), so that no significant difference between this and Ambergold-Silverblu is observed.

Comparison No. (80) shows that Ambergold has a greater reducing effect on Silverblu than that produced by Aleutian. The dm is .08, the significance is 2.68.

Adding Ambergold to the Breath of Spring-Silverblu-Aleutian combination produces a reduction in size.

Appendix No.	*year*	*dm*	*s*	*reduction*
(76)	1957	.51	12.00	13.46%
(78)	1957	.36	4.16	9.68%

The reduction made by Ambergold in hybrid males can be demonstrated by a 1957 comparison not listed in the appendix in which 47 Silverblu-Aleutian mean $3.72 \pm .0824 > 125$ Silverblu-Aleutian (hybrid for Ambergold) mean $3.32 \pm .0474$. dm = .40. s = 4.21. Reduction = 10.72%.

The reduction tendency of hybrid Ambergold seems also to be involved in comparison No. (79). In this case Ambergold-Aleutian is larger than Silverblu-Aleutian when hybrid for Ambergold. The dm is .43, the significance is 7.35, and the percentage reduction is 12.95%.

Palomino

Palomino in males definitely reduces Silverblu as shown by comparison No. (83). The dm is .70, the significance is 2.15, and the percentage reduction is 16.44%.

Palomino in males also reduces Breath of Spring-Silverblu, as shown in No. (82). The dm is .38, the significance is 5.19, the percentage reduction is 10.98%.

Palomino has an effect on hybrids, as shown by comparison No. (84). The dm is .46, the significance is 8.42, and the percentage reduction is 12.17%.

Moyle Buff

Moyle Buff carries with it such a strong tendency to large size that six comparisons of males and three out of four comparisons among females are significant.

There are three comparisons of Moyle Buff males with Dark.

Appendix No.	*year*	*dm*	*s*	*increase*
(87)	1956	.63	6.72	17.85%
(88)	1956	.41	2.87	10.93%
(89)	1957	.49	4.74	12.44%

Two female comparisons show Moyle Buff to be significantly larger than Dark mink.

Appendix No.	*year*	*dm*	*s*	*increase*
(91)	1954	.14	2.83	7.03%
(92)	1954	.21	2.73	10.55%

Silverblu makes a large mink, larger than the Dark, but Moyle Buff is significantly larger than Silverblu. There is one comparison of males.

Appendix No.	*year*	*dm*	*s*	*increase*
(85)	1954	.69	9.86	20.60%

For females there is a similar comparison.

Appendix No.	*year*	*dm*	*s*	*increase*
(93)	1955	.12	3.58	5.77%

Moyle Buff is even larger than Pastel, No. (86), which is actually larger than Silverblu although direction comparisons cannot be made between Pastel and Silverblu. The reason is that Silverblu-Pastel is an unmarketable, dull greenish mink, and, consequently, ranchers avoid crossing their blood lines.

Appendix No.	*year*	*dm*	*s*	*increase*
(86)	1954	.25	4.7	6.60%

There is a comparison showing the significant size increasing effect of Moyle Buff on Silverblu-Aleutian. The dm is .13 pounds, the significance is 2.81, and the percentage increase is 3.47%.

An interesting comparison is No. (94). Here the effect of the Moyle Buff gene in the hybrid is compared with its effect in homozygous state. In both cases it is on a Silverblu background. The dm is .12, but the significance is not quite satisfactory.

Moyle Buff Hybrids

There are a number of comparisons demonstrating the large effect produced by inserting into animals one gene for Moyle Buff rather than two genes for Moyle Buff. Because the Moyle Buff coat color is a recessive, this dominant physiological effect on growth in the hybrid is of considerable interest.

To begin with, there is the comparison of hybrid Moyle Buff with normal Dark, comparison No. (99). The dm is .38, the

significance is 3.12, and the percentage increase is 9.64.

In comparison No. (100) Pastel males are smaller than Pastel hybrid for Moyle Buff. The dm is .17, and the significance of 1.79 is almost satisfactory.

In comparison No. (95) Silverblu males hybrid for Moyle Buff are significantly larger than Silverblu hybrid for Aleutian. It is known that the Aleutian gene in simplex makes little difference in the size of a mink. The dm is .52 pounds, and the significance is 4.9. The percentage boost of this gene in simplex is 12.52%.

There are several comparisons of male animals hybrid for Moyle Buff and similar phenotypes hybrid for certain other genes. In No. (96) two groups of Dark mink are compared. One group is hybrid for Moyle Buff and the other hybrid for both Ambergold, which tends to reduce, and Silverblu, which appears to be neutral in simplex. The dm is .62 pounds, the significance is 7.46. The percentage increase is 16.85%.

In comparison No. (106) Silverblu females hybrid for Moyle Buff are larger than Silverblu hybrid for Ambergold. The dm is small, being .07, and the significance of 1.21 is insignificant. The percentage increase is 3.30.

Probably comparison No. (106) is not significant since it represents very few animals. Comparison No. (107) is of a similar nature, but deals with larger populations. Here the dm is .40, the significance is 12.19. The percentage increase is 2.09.

In No. (97) are compared Silverblu hybrid for Moyle Buff and Silverblu hybrid for Palomino which, as shown above, might have a reducing effect. The dm is .84, the significance is 10.85, and the percentage increase is 25.30%.

Comparison No. (98) shows that Silverblu hybrid for Moyle Buff is significantly larger than Silverblu hybrid for Ambergold. The dm is .38, the significance is 6.95, and the percentage increase is 10.05%.

From the foregoing it might be evpected that Aleutians hybrid for Moye Buff would be larger than plain Aleutians. This is demonstrated in comparison No. (101). The dm is .18, the significance is 2.43, and the percentage increase is 4.85%.

In comparison No. (108) Dark females hybrid for Moyle Buff are compared with Aleutian hybrid for Moyle Buff. The booster effect on size made by the Moyle Buff gene in simplex is similar in both cases, so that the normal percentage decrease of Aleutian, when compared with Dark, is maintained. The dm is .21, the significance is 3.31. The percentage decrease is 10.00%.

Two curious comparisons, Nos. (102) and (103), are recorded, which may mean that the single Moyle Buff gene in the presence of two genes for Silverblu plus two genes for Aleutian, loses its power to increase size! These are comparisons of Silverblu-

Aleutian hybrid for Moyle Buff with Silverblu-Aleutian. In one case the dm is .07, and in the other .04, although the size differences are in the expected direction. The significance in both cases is very low.

The above is also interesting in view of comparison No. (104) in which Silverblu-Aleutian for Moyle Buff is very much larger than Silverblu-Aleutian hybrid for Ambergold which was shown to have a reducing effect on its hybrids. The dm is .47, the significance is 8.23, and the percentage increase is 14.16%.

A very interesting fact is demonstrated by comparison No. (105). A recessive mutation turned up which the investigators call Dark Moyle Allel. It makes a coat color with much of the color quality of Moyle, but darker. When it is crossed with Moyle Buff, instead of obtaining a Dark mink, one obtains an animal something like Moyle Buff or slightly darker. In the absence of evidence to the contrary, these two genes would appear to be allels.

Curiously enough, however, the Dark Moyle Allel has little or no size influence on hybrids and none on purebreds.

In comparison No. (105) Moyle Buff males are compared with the Dark Moyle Allel. The dm is 1.18 pounds! The significance is 17.00! The percentage increase is 6.94.

Comparison No. (109) adds little of interest. It shows that Dark hybrid for Moyle Buff are larger than Dark hybrid for Ambergold and Silverblu. The dm is .18, the significance is 5.10, and the percentage increase is 8.45.

A similar effect on Aleutian is suggested in comparison No. (110). Aleutians carrying Moyle Buff in simplex are larger than Aleutians carrying one gene for Silverblu. The dm is .05, the significance is 1.27, and the percentage increase is 2.44.

Comparison (111) shows that when the purebred Dark strain has dropped in size because of the one error in selection, it may be identical in size with unselected, miscellaneous hybrids.

There are six genes for which measures of their effects are available, both in males and in females. In four of these the greatest effect is in the male, and in the other two it is in the female. However, the data are hardly sufficient to conclude that these genes actually have sex effects. Such effects conceivably can be due to errors of random sampling.

There are several genes the effects of which have been followed for twelve years (Chart 2.) During this time there has been found no evidence to indicate a change in the size effect of the coat color gene which might suggest linkage rather than pleiotropy. In the records all genes producing larger than normal size continued to do so (Moyle Buff, Silverblu, Pastel). All genes having a small size effect continued to produce a small size effect (Breath of Spring, Aleutian, Black Cross, Palomino, Ambergold).

THE BODY SIZE EFFECT OF VARIOUS MUTANTS IN PERCENT

Early Comparisons			Late Comparisons						
1946	1947	Others	1954	1955	1956	1957	1957	Total	
			7.03 / 10.55		17.85 / 10.93	12.44	3.47	10.41 / 8.79	Moyle Buff av. = 11.76% increase
5.1 / 8.6		8.2 / 11.13	6.53	4.63 / 12.56 / 7.80	14.45 / 7.73	8.12	5.53	7.70 / 0.31	Silverblu av = 8.38% increase
			4.52	8.17 / 10.41 / 3.80	13.33 / 12.75 / 5.55	5.84	6.84	8.73 / 5.03	Pastel av = 7.91% increase
1.0 / 0.6	3.2 / 3.3	9.0 / 3.0 / 5.2 / 1.9					5.86 4.98 / 1.83 5.00 / 1.41 4.98 5.00 / 1.47 2.88	3.91 / 2.78	Breath of Spring av = 3.50% decrease
5.1 / 8.9	6.4 / 7.2							5.75 / 8.05	Black Cross av = 6.90% decrease
			4.52	3.94 7.34 / 3.94 / 2.12 / 3.76	6.93		7.42 12.83 / 5.20 10.14 / 7.45 2.09 / 5.58 4.55 / 7.27	5.56 / 4.14	Aleutian av = 5.35% decrease
							16.44 / 10.98	13.71	Palomino av = 13.71% decrease
							10.40 9.68 / 11.74 / 13.46	11.32	Ambergold av — 11.32% decrease

TABLE 2. A list of mean body weights, represented in percent of standard Dark mink weight associated with sub-populations bearing simple coat colors, at the beginning and end of the twelve year period of study, to show relative constancy in amount and direction of the deviations. Data for males are at the upper left of the rectangles; data for females at the lower right.

In combination through twelve years Breath of Spring combined to reduce the plus effect of Silverblu in animals manifesting both Breath of Spring and Silverblu genes.

FIGURE 1. *Wooden vector-models to illustrate the plus or minus size effects of the various coat color genes of mink included in this study. The vector quantities representing increaser or decreaser effects are in percentage of the mean size of normal Dark mink taken as 100%. The assembled model illustrates the interaction between Breath of Spring, Silverblu, Aleutian, and Palomino genes resulting in a mink smaller than normal size.*

If the present interpretation is correct, then the effects of the coat color genes studied may be represented as vector quantities, directed either upward or downward from a horizontal line representing quantitatively the position of the normal mean.

If the horizontal line of the normal mean is represented by a long block of wood pierced with holes, and the vector quantities represented by wooden arrows, the rear ends of the shafts of which fit snugly into these holes, then visual models of the forces acting on size in each genetic combination may be constructed. Such models allow visualization of these growth forces much as molecular models assist the chemist to comprehend the relative positions of the interacting atoms; see Figure 1. In addition, they permit comparison of genetic combinations in terms of percentage, thus giving a common unit of comparisons not available in terms of the actual weights, due to sex differences and the general annual selection for larger size which was effective upon genes not tagged by means of coat color modifications.

The genetic models of 45 combinations of genes from late comparisons were prepared and are presented in five charts in which the difference between the means of the populations was found to be significant. Those comparisons are listed in the Appendix and are referred to by letters of the alphabet. See Charts 3, 4, 5, 6, 7. An examination of these comparisons between models will reveal that none are inconsistent with the interpretation given to the various size tendencies and their interactions described in this paper.

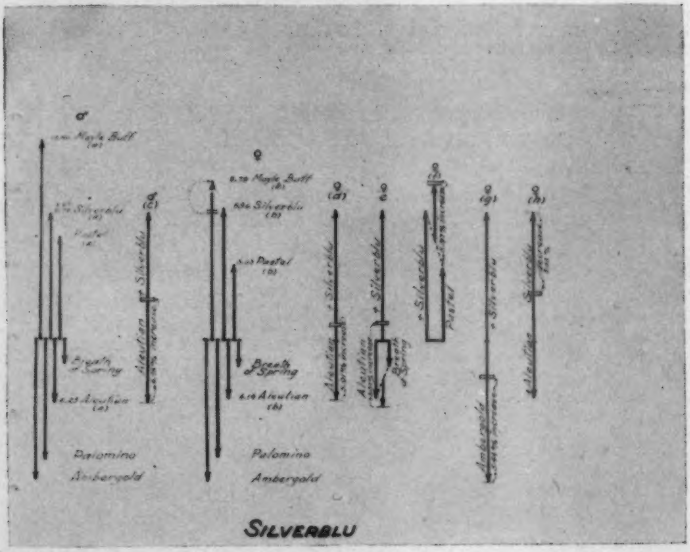

Chart 3.

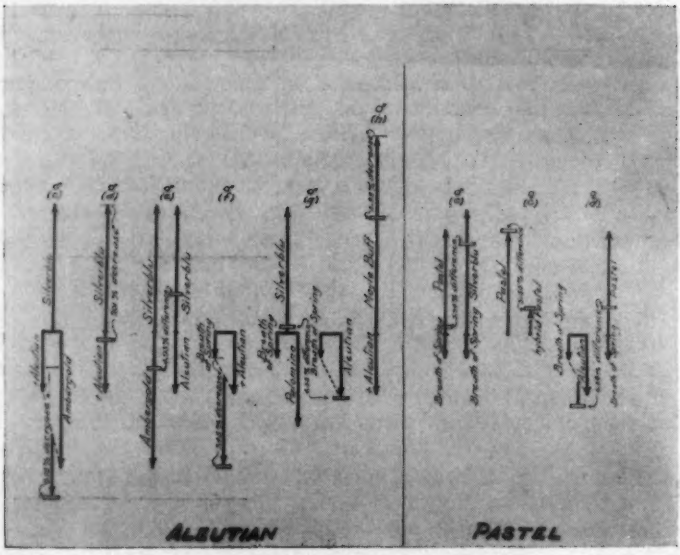

Chart 4.

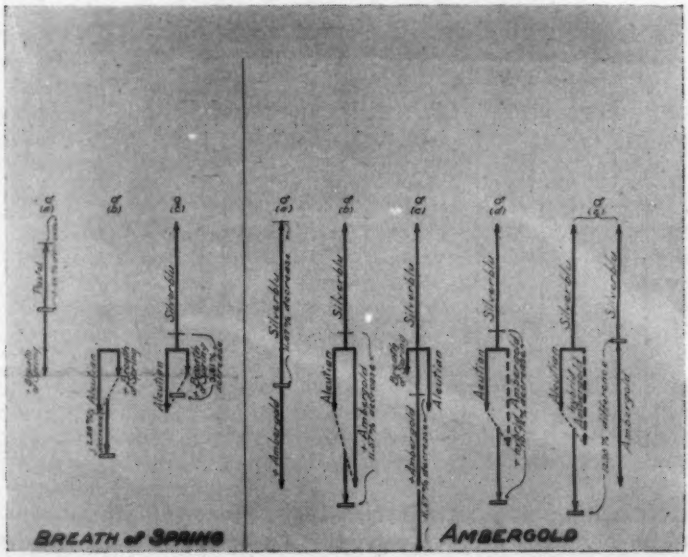

Chart 5.

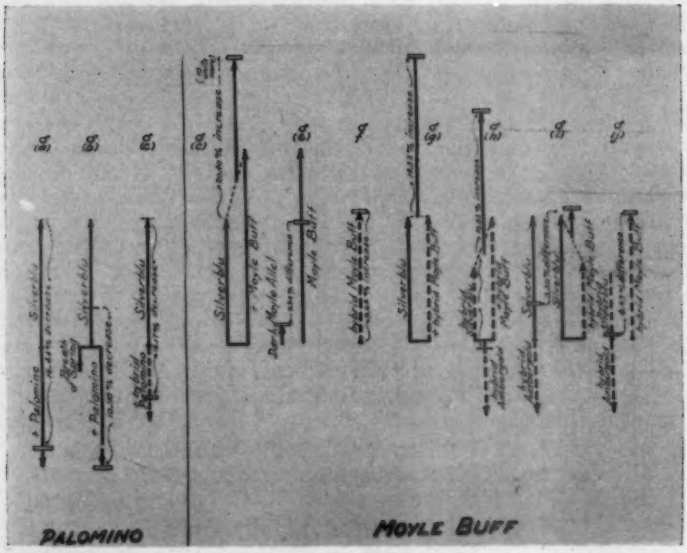

Chart 6.

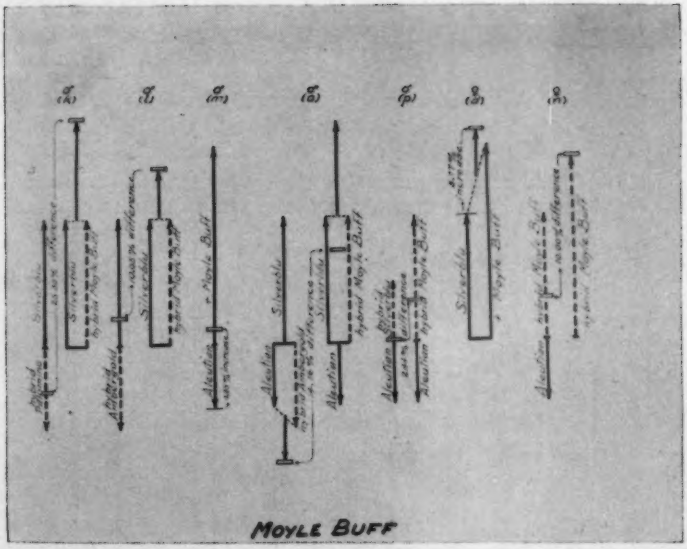

CHART 7. *Charts 3, 4, 5, 6, 7. Vector quantity models representing the growth tendencies of certain coat color constitutions of mink and their comparisons as listed in the index under the title of "Late Comparisons,"*

Several thousand dissections were made, the details of which do not concern this report except that from them it was learned that certain genes, such as Aleutian, make short, slender animals. Certain other genes, such as Silverblu, make large, stocky animals. Moyle Buff makes long, large animals. The Moyle Buff-Silverblu combination is enormous, being both very large and very stocky, apparently manifesting the size and shape tendencies of both Moyle Buff and Silverblu.

Pelted carcasses of Pastel and Dark mink of the 1947 crop were weighed in grams and body length measured in millimeters (nose to rump). The Pastels, both males and females, are significantly larger than the Darks.

Seventy-five Pastel males having a mean weight of 975.24 ± 17.88 > 52 Dark males having a mean weight of 924.30 ± 16.95. dm = 50.94 ± 24.64. s = 2.07. diff = 5.23%.

Fifty-three Pastel females having a mean weight of 587.66 ± 8.30 > 50 Dark females having a mean weight of 543.96 ± 6.55. dm = 43.70 ± 10.57. s = 4.13. diff = 7.44%.

The Pastels, both males and females, are longer in body than the Darks.

Seventy-five Pastel males having a mean length of 592.98 ± 3.04 > 52 Dark males having a mean length of 572.34 ± 5.01. dm = 20.64 ± 5.86. s = 3.52. diff. = 3.38%.

Fifty-three Pastel females having a mean length of 502.52 ± 4.25 > 49 Dark females having a mean length of 508.55 ± 3.55. dm = 6.03 ± 5.54. s = 1.09. diff = 1.19%.

The length comparison on this small number of females is not statistically significant although Pastels are 1.19% shorter than Darks. The length comparison shows Pastel males significantly longer than Dark males.

DISCUSSION AND CONCLUSIONS

1. Since over a period of twelve years the correlation between a particular coat color and a particular size tendency has not been found to change, it appears most probable that the coat color gene itself, rather than a linked gene, produces the associated size tendency, either large or small in the material studied.
2. Certain coat color genes, such as those for Moyle Buff, Silverblu, and Pastel, tend to produce animals of larger size than normal Dark. Certain others, such as those for Breath of Spring, Aleutian, Palomino, and Ambergold, produce animals smaller than normal.
3. The size tendency of each coat color gene is manifested in both males and females, although there are marked differences in body weight between the two sexes because of sex factors.

4. Heterozygosity for various coat colors may produce detectable effects on body size. Breath of Spring is due to a dominant gene, lethal in the homozygous state. The other genes dealt with are recessives, and of these, Moyle Buff, Palomino, and Ambergold manifest effects on body size in the heterozygote.
5. Two large-size genes in the same animal in homozygous state tend to produce animals still larger than would be produced by either gene alone. However, this is accompanied by a discount, isnce the resultant size is never quite equal to the sum of the increases made by the two genes acting alone.
6. Two small size genes tend to produce animals smaller than would be produced by either gene alone. Here again, the reduction is not as great as the sum of the reductions made by the two genes acting alone.
7. The effects of genes making for larger than normal size tend to be neutralized by the effects of genes making for smaller than normal size.
8. A certain gene for small size may act differently in combination with a certain large-size gene than in combination with another certain gene for large size.
9. It was observed that certain genes, such as Aleutian, tend to make short, slender animals. Others, such as Silverblu, tend to produce large, stocky animals. Moyle Buff tends to make long, large animals. The combination between Silverblu and Moyle Buff produces animals both long and stocky, apparently manifesting the outstanding tendencies of both genes.

Thus, it may be concluded that a study of body length and body shape would reveal certain lengths and proportions associated with certain genes and manifesting themselves in combinations of these genes in much the same fashion that body weight does.

SUMMARY

A statistical study of weight data was made over a period of twelve years upon a population of over 100,000 ranch-bred mink. This study revealed that certain coat color genes tend to produce larger than normal Dark body size (weight) and that others tend to produce smaller than normal body size. These size effects tend to be somewhat additive (when the plus and minus signs are respected) in that two plus genes in the same animal make it still larger, two minus genes make it still smaller, and a plus gene in combination with a minus gene tends to cancel out their size deviations from normal. Some size tendencies of coat color genes are detectable in heterozygotes.

ACKNOWLEDGEMENT

The author is indebted to Larry Moore and the staff of his mink ranch for their generous cooperation on this problem for more than a decade. He is grateful to Sir Ronald Fisher with whom he discussed the adequacy for this material of the simple statistical method of analysis employed.

Expenses in connection with this study were met from a seven-year grant-in-aid made to the author by the Rockefeller Foundation and, thereafter, through a two-year grant from the Southern Fellowship Fund and the Faculty Research Fund of the Georgia State College for Women.

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APPENDIX

COMPARISON OF BODY WEIGHTS OF SUB-POPULATIONS SEGREGATING FOR COAT COLOR

dm is difference between means. s is "Significance" which represents the difference between means divided by the standard error of the difference betwen the means. diff is difference in percent.

Early Comparisons

SILVERBLU MALES

(1) *Silverblu 1946.* 584 Silverblu mean 3.32 ± .024 > 189 Dark mean 3.15 ± 0.35. dm = .17 ± .042. s = 4.0. diff = 5.1%.

(2) *Silverblu 1946.* 584 Silverblu mean 3.32 ± .024 > 292 Breath of Spring-Silverblu mean 3.29 ± .023. dm = .03 ± .033. s = 0.9. diff = 0.9%.

(3) *Silverblu 1946.* 534 Silverblu mean 3.32 ± .024 > 149 Breath of Spring mean 3.02 ± .037. dm = .30 ± .044. s = 6.8. diff = 9.0%.

(4) *Silverblu 1946.* 584 Silverblu mean 3.32 ± .024 > 188 Black Cross mean 2.99 ± .035. dm = .33 ± .042. s = 7.8. diff = 10.0%.

(5) *Silverblu 1947.* 537 Silverblu mean 3.42 ± .025 < 266 Dark mean 3.43 ± .035. dm = .01 ± .043. s = 0.23. diff = 0.3%.

(6) *Silverblu 1947.* 537 Silverblu mean 3.42 ± .025 > 473 Breath of Spring-Silverblu mean 3.32 ± .025. dm = .10 ± .035. s = 2.86. diff = 3.0%.

(7) *Silverblu 1947.* 537 Silverblu mean 3.42 ± .025 > 28 Breath of Spring mean 3.20 ± .097. dm = .22 ± .100. s = 2.2. diff = 6.4%.

(8) *Silverblu 1947.* 537 Silverblu mean 3.42 ± .025 > 54 Black Cross mean 3.21 ± .063. dm = .21 ± .068. s = 3.08. diff = 6.2%.

SILVERBLU FEMALES

(9) *Silverblu 1946.* 511 Silverblu mean 2.10 ± .004 > 185 Dark mean 1.92 ± .016. dm = .18 ± .016. s = 11.2. diff = 8.6%.

(10) *Silverblu 1946.* 511 Silverblu mean 2.10 ± .004 > 273 Breath of Spring-Silver mean 1.99 ± .018. dm = .11 ± .018. s = 6.1. diff = 5.2%.

(11) *Silverblu 1946.* 511 Silverblu mean 2.10 ± .004 > 133 Breath of Spring mean 1.77 ± .017. dm = .33 ± .017. s = 19.4. diff = 5.7%.

(12) *Silverblu 1946.* 511 Silverblu mean 2.10 ± .004 > 193 Black Cross mean 1.76 ± .015. dm = .34 ± .015. s = 22.7. diff = 6.2%.

(13) *Silverblu 1947.* 527 Silverblu mean 2.10 ± .014 > 216 Dark mean 2.08 ± .017. dm = .03 ± .022. s = 1.36. diff = 1.0%.

(14) *Silverblu 1947.* 527 Silverblu mean 2.10 ± .014 > 394 Breath of Spring-Silverblu mean 2.06 ± .015. dm = .04 ± .020. s = 2.0. diff = 1.9%.

(15) *Silverblu 1947.* 527 Silverblu mean 2.10 ± .014 > 16 Breath of Spring mean 1.95 ± .067. dm = .15 ± .068. s = 2.20. diff = 7.2%.

(16) *Silverblu 1947.* 527 Silverblu mean 2.10 ± .014 > 44 Black Cross mean 1.93 ± .028. dm = .17 ± .083. s = 2.05. diff = 8.1%.

BREATH OF SPRING MALES

(17) *Breath of Spring 1946.* 149 Breath of Spring mean 3.02 ± .037 > 188 Black Cross mean 2.99 ± .035. dm = .03 ± .051. s = 0.6. diff = 1.0%.

(18) *Breath of Spring 1496.* 189 Dark mean 3.15 ± .035 > 149 Breath of Spring mean 3.02 ± .037. dm = .13 ± .051. s = 2.5. diff = 4.2%.

(19) *Breath of Spring 1947.* 473 Breath of Spring mean 3.32 ± .025 < Dark mean 3.43 ± .035. dm = .11 ± .045. s = 2.44. diff = 3.2%.

(20) *Breath of Spring 1947.* 473 Breath of Spring mean 3.32 ± .025 > 54 Black Cross mean 3.21 ± .063. dm = .11 ± .068. s = 1.62. diff = 3.3%.

BREATH OF SPRING FEMALES

(21) *Breath of Spring 1946.* 133 Breath of Spring mean 1.77 ± .017 > 193 Black Cross mean 1.76 ± .015. dm = .01 ± .023. s = 0.4. diff = 0.6%.

BREATH OF SPRING MALES

(22) *Breath of Spring 1946.* 185 Dark mean 1.92 ± .016 > 133 Breath of Spring mean 1.77 ± .017. dm = .15 ± .023. s = 6.5. diff = 7.8%.

(23) *Breath of Spring 1947.* 394 Breath of Spring mean 2.06 ± .015 < 216 Dark mean 2.08 ± .017. dm = .02 ± .023. s = 0.87. diff = 1.0%.

(24) *Breath of Spring 1947.* 394 Breath of Spring mean 2.06 ± .015 > 44 Black Cross mean 1.93 ± .028. dm = .13 ± .032. s = 4.06. diff = 6.3%.

BREATH OF SPRING-SILVERBLU MALES

(25) *Breath of Spring-Silverblu 1946.* 292 Breath of Spring-Silverblu mean 3.29 ± .023 > 189 Dark mean 3.15 ± .035. dm = .14 ± .042. s = 3.3. diff = 4.3%.

(26) *Breath of Spring-Silverblu 1946.* 292 Breath of Spring-Silverblu mean 3.29 ± .023 > 149 Breath of Spring mean 3.02 ± .037. dm = .27 ± .043. s = 6.3. diff = 8.2%.

(27) *Breath of Spring-Silverblu 1946.* 292 Breath of Spring-Silverblu mean 3.29 ± .023 > 188 Black Cross mean 2.99 ± .035. dm = .30 ± .042. s = 7.1. diff = 8.1%.

(28) *Breath of Spring-Silverblu 1947.* 473 Breath of Spring-Silverblu mean 3.32 ± .025 < 266 Dark mean 3.43 ± .025. dm = .11 ± .035. s = 3.14. diff = 3.2%.

(29) *Breath of Spring-Silverblu 1947.* 473 Breath of Spring-Silverblu mean 3.32 ± .025 > 28 Breath of Spring mean 3.20 ± .097. dm = .12 ± .100. s = 1.2. diff = 3.6%.

(30) *Breath of Spring-Silverblu 1947.* 473 Breath of Spring-Silverblu mean 3.32 ± .025 > 54 Black Cross mean 3.21 ± .063. dm = .11 ± .068. s = 1.62. diff = 3.3%.

BREATH OF SPRING-SILVERBLU FEMALES

(31) *Breath of Spring-Silverblu 1946.* 273 Breath of Spring-Silverblu mean 1.99 ± .018 > 185 Dark mean 1.92 ± .016. dm = .07 ± .024. s = 2.9. diff = 3.5%.

(32) *Breath of Spring-Silverblu 1946.* 273 Breath of Spring-Silverblu mean 1.99 ± .018 > 133 Breath of Spring mean 1.77 ± .017. dm = .22 ± .025. s = 8.8. diff = 11.1%.

(33) *Breath of Spring-Silverblu 1946.* 273 Breath of Spring-Silverblu mean 1.99 ± .018 > 193 Black Cross mean 1.76 ± .015. dm = .23 ± .024. s = 9.16. diff = 11.6%.

(34) *Breath of Spring-Silverblu 1947.* 394 Breath of Spring-Silverblu mean 2.06 ± .015 < 216 Dark mean 2.08 ± .017. dm = .02 ± .023. s = 0.87. diff = 1.0%.

(35) *Breath of Spring-Silverblu 1947.* 394 Breath of Spring-Silverblu mean 2.06 ± .015 > 16 Breath of Spring mean 1.95 ± .067. dm = .11 ± .069. s = 1.59. diff = 5.3%.

(36) *Breath of Spring-Silverblu 1947.* 394 Breath of Spring-Silverblu mean 2.06 ± .015 > 44 Black Cross mean 1.93 ± .028. dm = .13 ± .032. s = 4.06. diff = 6.3%.

BLACK CROSS MALES

(37) *Black Cross 1946.* 189 Dark mean 3.15 ± .035 > 188 Black Cross mean 2.99 ± .035. dm = .16 ± .038. s = 4.2. diff = 5.1%.

(38) *Black Cross 1947.* 54 Black Cross mean 3.21 ± .063 < 266 Dark mean 3.43 ± .035. dm = .22 ± .072. s = 3.05. diff = 6.4%.

BLACK CROSS FEMALES

(39) *Black Cross 1946.* 185 Dark mean 1.92 ± .016 > 193 Black Cross mean 1.75 ± .015. dm = .16 ± .022. s = 7.3. diff = 8.9%.

(40) *Black Cross 1947.* 44 Black Cross mean 1.93 ± .028 < 216 Dark mean 2.08 ± .017. dm = .15 ± .033. s = 4.54. diff = 7.2%.

LATE COMPARISONS

SILVERBLU MALES

(1) *Silverblu 1954.* 470 Silverblu-Aleutian mean 3.28 ± .0214 > 111 Aleutian (hybrid for Silverblu) mean 3.16 ± .0319. dm = .12 ± .0384. s = 3.1.

(2) *Silverblu 1954.* 422 Silverblu-Breath of Spring-Aleutian mean 3.22 ± .0208 > 115 Breath of Spring-Aleutian (hybrid for Silverblu) mean 3.16 ± .0319. dm = .06 ± .0381. s = 1.57.

(3) *Silverblu 1954.* 49 Silverblu (hybrid for Moyle Buff) mean 3.87 ± .0804 > 191 Dark (hybrid for Moyle Buff) mean 3.85 ± .0503. dm = .02 ± .0948. s = 0.21.

(4) *Silverblu 1955.* 191 Silverblu (carry Ambergold) mean 3.78 ± .0345 > 42 Dark (wild type) mean 3.55 ± .0706. dm = .23 ± .0785. s = 2.93.

(5) *Silverblu 1956.* 23 Silverblu mean 4.04 ± .1465 > 63 Dark (miscellaneous hybrids) mean 3.53 ± .0920. dm = .51 ± .1729. s = 2.88.

(6) *Silverblu 1956.* 23 Silverblu mean 4.04 ± .1465 > 10 Dark (wild type) mean 3.94 ± .0967. dm = .32 ± .0936. s = 1.42.

(7) *Silverblu 1957.* 19 Silverblu mean 4.26 ± .0646 > 27 Dark (wild type) mean 3.94 ± .0967. dm = .32 ± .9036. s = 3.43.

SILVERBLU FEMALES

(8) *Silverblu 1954.* 67 Silverblu (hybrid for Aleutian) mean 2.20 ± .0541 > 208 Pastel mean 2.08 ± .0182. dm = .12 ± .0571. s = 2.10.

(9) *Silverblu 1954.* 25 Silverblu mean 2.12 ± .0428 = 37 Breath of Spring-Silverblu (hybrid for Aleutian) mean 2.12 ± .0476. no dm.

(10) *Silverblu 1954.* 67 Silverblu (hybrid for Aleutian) mean 2.20 ± .0541 > 37 Breath of Spring-Silverblu (hybrid for Aleutian) mean 2.12 ± .0476. dm = .08 ± .0720. s = 1.1.

(11) *Silverblu 1954.* 67 Silverblu (hybrid for Aleutian) mean 2.20 ± .0541 > 168 Aleutian (hybrid for Silverblu) mean 2.08 ± .0164. dm = .12 ± .0559. s = 2.15.

(12) *Silverblu 1954.* 453 Silverblu-Aleutian mean 2.04 ± .0127 < 168 Aleutian (hybrid for Silverblu) mean 2.08 ± .0160. dm = .04 ± .0204. s = 1.96.

(13) *Silverblu 1954.* 37 Silverblu-Breath of Spring (hybrid for Aleutian) mean 2.12 ± .0476 > 177 Pastel-Breath of Spring mean 2.08 ± .0191. dm = .04 ± .0513. s = .08.

(14) *Silverblu 1954.* 325 Silverblu-Breath of Spring-Aleutian mean 2.01 < 87 Breath of Spring-Aleutian (hybrid for Silverblu) mean 2.02 ± .0253. dm = .01 ± .0292. s = .03.

(15) *Silverblu 1954.* 25 Silverblu (hybrid for Ambergold) mean 2.12 ± .0428 > Dark mean 1.99 ± .0272. dm = .13 ± .0507. s = 2.56.

(16) *Silverblu 1955.* 190 Silverblu (hybrid for Ambergold) mean 2.15 ± .0203 > 77 Dark (hybrid for Silverblu and Ambergold) 1.91 ± .0290. dm = .24 ± .0354. s = 6.78.

(17) *Silverblu 1955.* 158 Silverblu-Ambergold mean 2.13 ± .0205 > 141 Dark (hybrid for Ambergold and Silverblu) mean 2.02 ± .0228. dm = .11 ± .0300. s = 3.66.

(18) *Silverblu 1955.* 190 Silverblu (hybrid for Ambergold) mean 2.15 ± .0203 > 141 Dark (hybrid for Silverblu and Ambergold) mean 2.02 ± .0228. dm = .13 ± .0305. s = 4.26.

(19) *Silverblu 1955.* 157 Silverblu-Aleutian mean 2.21 ± .0216 > 80 Aleutian mean 2.05 ± .0277. dm = .16 ± .0351. s = 1.56.

(20) *Silverblu 1955.* 136 Silverblu-Breath of Spring-Aleutian mean 2.10 ± .0233 > 56 Breath of Spring-Aleutian (hybrid for Silverblu) mean 1.99 ± .0296. dm = .11 ± .0376. s = 2.92.

(21) *Silverblu 1956.* 213 Silverblu-Aleutian mean 2.03 ± .0137 > 145 Aleutian mean 2.00 ± .0167. dm = .03 ± .0216. s = 1.39.

(22) *Silverblu 1956.* 64 Silverblu-Moyle Buff mean 2.15 ± .0319 > 418 Moyle Buff mean 2.09 ± .0120. dm = .06 ± .0341. s = 1.76.

ALEUTIAN MALES

(23) *Aleutian 1954.* 422 Aleutian-Breath of Spring-Silverblu mean 3.22 ± .0208 < 37 Breath of Spring-Silverblu mean 3.46 ± .0652. dm = .24 ± .0680. s = 3.5.

(24) *Aleutian 1954.* 422 Aleutian-Breath of Spring-Silverblu mean 3.08 ± .0332 < 184 Breath of Spring-Silverblu-Palomino mean 3.22 ± .0208. dm = .14 ± .0392. s = 3.6. Aleutian reduces more than Palomino.

(25) *Aleutian 1954.* 470 Aleutian-Silverblu mean 3.28 ± .0214 < 37 Silverblu (hybrid for Aleutian) mean 3.46 ± .0652. dm = .18 ± .0498. s = 3.61.

(26) *Aleutian 1954.* 470 Aleutian-Silverblu mean 3.28 ± .0214 < Silverblu mean 3.35 ± .0681. dm = .07 ± .0713. s = 1.0.

(27) *Aleutian 1955.* 191 Silverblu (hybrid for Ambergold) mean 3.78 ± .0345 > 13 Silverblu-Aleutian mean 3.35 ± .0468. dm = .43 ± .0581. s = 7.40.

(28) *Aleutian 1955.* 42 Dark (wild type) mean 3.55 ± .0766 > 98 Aleutian (hybrid for Silverblu) mean 3.49 ± .0495. dm = .14 ± .0866. s = 0.70.

(29) *Aleutian 1955.* 42 Dark (wild type) mean 3.55 ± .0766 > 108 Aleutian (hybrid for Silverblu) mean 3.41 ± .0503. dm = .14 ± .0866. s = 1.62.

(30) *Aleutian 1955.* 43 Dark (hybrid for Silverblu and Ambergold) mean 3.68 ± .0745 > 98 Aleutian (hybrid for Silverblu) mean 3.49 ± .0495. dm = .19 ± .0894. s = 2.12.

(31) *Aleutian 1955.* 43 Dark (hybrid for Silverblu and Ambergold) mean 3.68 ± .0745 > 108 Aleutian (hybrid for Silverblu) mean 3.41 ± .0503. dm = .27 ± .0893. s = 3.02.

(32) *Aleutian 1956.* 10 Dark (wild type) mean 3.75 ± .1413 > 254 Aleutian (hybrid for other genes) mean 3.49 ± .0308. dm = .26 ± .1446. s = 1.80.

(33) *Aleutian 1956.* 63 Dark (miscellaneous hybrids) mean 3.53 ± .0920 > 254 Aleutian (hybrid for other genes) mean 3.49 ± .0308. dm = .04 ± .0959. s = 0.42.

(34) *Aleutian 1956.* 348 Silverblu-Ambergold mean 3.62 ± .0269 > 73 Silverblu-Ambergold-Aleutian mean 3.37 ± .0491. dm = .25 ± .0559. s = 4.47.

(35) *Aleutian 1957.* 236 B of S-Silverblu-Ambergold mean 3.65 ± .0312 > 95 B of S-Silverblu-Ambergold-Aleutian mean 3.28 ± .0382. dm = .37 ± .0493. s = 7.90.

ALEUTIAN FEMALES

(36) *Aleutian 1954.* 453 Aleutian-Silverblu mean 2.04 ± .0127 < 67 Silverblu (hybrid for Aleutian) mean 2.20 ± .0541. dm = .16 ± .0556. s = 2.88.

(37) *Aleutian 1954.* 453 Aleutian-Silverblu mean 2.04 ± .0127 < 25 Silverblu (hybrid for Ambergold) mean 2.12 ± .0428. dm = .08 ± .0446. s = 1.79.

(38) *Aleutian 1954.* 168 Aleutian (hybrid for Silverblu) mean 2.08 ± .0164 < 49 Dark mean 1.99 ± .0272. dm = .09 ± .0164. s = 2.83.

(39) *Hybrid Aleutian 1954.* 67 Silverblu (hybrid for Aleutian) mean 2.20 ± .0541 > 25 Silverblu (hybrid for Ambergold) mean 2.12 ± .0428. dm = .08 ± .0690. s = 1.16.

(40) *Aleutian 1955.* 80 Aleutian (hybrid for Silverblu) mean 2.05 ± .0277 < 65 Dark (hybrid for Ambergold and Silverblu) mean 2.13 ± .0318. dm = .8. s = 1.89.

(41) *Aleutian 1955.* 77 Aleutian-Silverblu-Breath of Spring mean 3.40 ± .0513 < 141 Silverblu-Ambergold-Breath of Spring mean 3.41 ± .0387. dm = .01 ± .0642. s = .15.

(42) *Aleutian 1956.* 56 Aleutian-Moyle Buff-Silverblu mean 2.03 ± .0323 < 64 Moyle Buff-Silverblu mean 2.15 ± .0319. dm = .12 ± .0323. s = 2.64.

(43) *Aleutian 1956.* 213 Aleutian-Silverblu mean 2.03 ± .0137 > 301 Silverblu-Ambergold mean 1.93 ± .0154. dm = .10 ± .0206. s = 4.85.

PASTEL MALES

(44) *Pastel 1954.* 154 Pastel-Breath of Spring mean 3.58 ± .0450 > 37 Breath of Spring-Silverblu mean 3.46 ± .0652. dm = .12. s = 1.51.

(45) *Pastel 1955.* 48 Pastel-Breath of Spring mean 3.80 ± .0617 > 23 Breath of Spring mean 4.04 ± .1465. dm = .24. s = .15.

(46) *Pastel 1955.* 238 Pastel mean 3.84 ± .0345 > 42 Dark (wild type) mean 3.55 ± .0706. dm = .29 ± .0787. s = 3.68.

(47) *Pastel 1955.* 238 Pastel mean 3.84 ± .0345 > 71 Dark (hybrid for Ambergold) mean 3.46 ± .0659. dm = .36 ± .0743. s = 4.84.

(48) *Pastel 1955.* 238 Pastel mean 3.84 ± .0345 > 43 Dark (hybrid for Ambergold and Silverblu) mean 3.68 ± .0745. dm = .14 ± .0820. s = 1.71.

(49) *Pastel 1956.* 534 Pastel mean 4.25 ± .0213 > 10 Dark (wild type) mean 3.75 ± .1413. dm = .50 ± .1428. s = 3.50.

(50) *Pastel 1956.* 152 Pastel (hybrid for B of S) mean 3.98 ± .0455 > 63 Dark (miscellaneous hybrids) mean 3.53 ± .0920. dm = .45 ± .1020. s = 4.40.

(51) *Pastel 1957.* 222 Pastel mean 4.17 ± .0411 > 27 Dark (wild type) mean 3.94 ± .0967. dm = .23 ± .1057. s = 2.17.

(52) *Pastel 1954.* 208 Pastel mean 2.08 ± .0182 > 49 Dark mean 1.99 ± .0272. dm = .09 ± .0327. s = 2.75.

(53) *Pastel 1956.* 400 Pastel mean 2.04 ± .0138 < 364 Dark (hybrid for Pastel) mean 2.16 ± .0131. dm = .12 ± .0190. s = 6.31.

(54) *Pastel 1956.* 152 Pastel-Blufrost mean 2.03 ± .0258 > 54 Blufrost-Aleutian mean 1.90 ± .0336. dm = .13 ± .0424. s = 3.06.

(55) *Hybrid Pastel 1956.* 364 Dark (hybrid for Pastel) mean 2.16 ± .0131 > 19 Dark mean 2.01 ± .0480. dm = .15 ± .0497. s = 3.02.

BREATH OF SPRING MALES

(56) *Breath of Spring 1954.* 115 Breath of Spring-Aleutian (hybrid for Silverblu) mean 3.16 ± .0319 < 111 Aleutian (hybrid for Silverblu) mean 3.21 ± .0355. dm = .05 ± .0462. s = 1.1.

(57) *Breath of Spring 1954.* 422 Breath of Spring-Silverblu-Aleutian mean 3.22 ± .0208 < 470 Silverblu-Aleutian mean 3.28 ± .0214. dm = .06 ± .0299. s = 2.0.

(58) *Breath of Spring 1954.* 37 Breath of Spring-Silverblu (hybrid for Aleutian) mean 3.46 ± .0652 < 56 Silverblu (hybrid for Aleutian) mean 3.35 ± .0509. dm = .11 ± .5140. s = 2.14.

(59) *Breath of Spring 1954.* 154 Breath of Spring-Pastel mean 3.58 ± .0450 < 119 Pastel mean 3.79 ± .0511. dm = .21 ± .0680. s = 3.1.

(60) *Breath of Spring 1955.* 48 Breath of Spring-Pastel mean 3.80 ± .0617 < 238 Pastel mean 3.82 ± .0345. dm = .02 ± .0707. s = .28.

(61) *Breath of Spring 1955.* 77 Breath of Spring-Silverblu-Aleutian mean 3.40 ± .0513 > 13 Silverblu-Aleutian mean 3.35 ± .0468. dm = .05 ± .0694. s = .72.

(62) *Breath of Spring 1956.* 23 B of S mean 4.04 ± .1465 > 19 Silverblu-B of S mean 3.90 ± .1100. dm = .14 ± .1832. s = 0.76.

(63) *Breath of Spring Hybrids 1956*.....534 Pastel mean 4.25 ± .0213 > 152 Pastel (hybrid for Breath of Spring) mean 3.98 ± .0455. dm = .27 ± .0228. s = 11.84.

(64) *Breath of Spring I957.* 222 Pastel mean 4.17 ± .0411 > 13 B of S mean 3.88 ± .1130. dm = .23 ± .1057. s = 6.81.

BREATH OF SPRING FEMALES

(65) *Breath of Spring 1954.* 325 Breath of Spring-Silverblu-Aleutian mean 2.01 ± .0145 < 453 Silverblu-Aleutian mean 2.04 ± .0127. dm = .03 ± .0193. s = 1.55.

(66) *Breath of Spring 1954.* 177 Breath of Spring-Pastel mean 2.08 ± .0191 = 208 Pastel mean 2.08 ± .0182. no dm.

(67) *Breath of Spring 1954.* 87 Breath of Spring-Aleutian (hybrid for Silverblu) mean 2.02 ± .0253 < 168 Aleutian (hybrid for Silverblu) mean 2.08 ± .0164. dm = .06 ± .0301. s = 1.99.

(68) *Breath of Spring 1955.* 56 Breath of Spring-Aleutian (hybrid for Silverblu) mean 1.99 ± .0296. dm = .06 ± .0296. s = 1.61.

(69) *Breath of Spring 1955.* 136 Breath of Spring-Silverblu-Aleutian mean 2.10 ± .0233 < 157 Silverblu-Aleutian mean 2.21 ± .0216. dm = .11 ± .0317. s = 3.47.

(70) *Breath of Spring 1955.* 71 Breath of Spring-Pastel mean 2.08 ± .0321 > 253 Pastel mean 2.02 ± .0194. dm = .06 ± .0321. s = 1.87.

(71) *Breath of Spring 1955.* 77 Breath of Spring-Silverblu-Aleutian mean 3.40 ± .0513 > 131 Silverblu-Aleutian mean 3.35 ± .0468. dm = .05 ± .0694. s = 0.72.

(72) *Breath of Spring 1956.* 152 Breath of Spring-Pastel mean 2.03 ± .0258 < 400 Pastel mean 2.04 ± .0138. dm = .01 ± .0292. s = 0.30.

(73) *Breath of Spring 1956.* 54 Breath of Spring-Aleutian (hybrid for Ambergold) mean 1.90 ± .0336 < 145 Aleutian mean 2.00 ± .0167. dm = .10 ± .0375. s = 2.67.

AMBERGOLD MALES

(74) *Ambergold 1956.* 23 Silverblu mean 4.04 ± .1465 > 348 Silverblu-Ambergold mean 3.62 ± .0269. dm = .42 ± .1489. s = 2.82.

(75) *Ambergold Hybrids 1955.* 42 Dark (wild type) mean 3.55 ± .0706 >71 Dark (hybrid for Ambergold) mean 3.46 ± .0659. dm = .09 ± .0912. s = 0.97.

(76) *Ambergold 1957.* 73 B of S-Aleutian-Silverblu mean 3.79 ± .0591 > 95 B of S-Aleutian-Silverblu-Ambergold mean 3.28 ± .0382. dm = .51 ± .0425. s = 12.00.

(77) *Ambergold 1957.* 19 Silverblu mean 4.26 ± .0646 > 377 Silverblu-Ambergold mean 3.76 ± .0253. dm = .50 ± .0693. s = 7.21.

(78) *Ambergold 1957.* 47 Silverblu-Aleautian mean 3.72 ± .0824 > 218 Silverblu-Aleutian-Ambergold mean 3.36 ± .0268. dm = .36 ± .0866. s = 4.16.

(79) *Ambergold Hybrids 1957.* 136 Ambergold-Aleutian mean 3.75 ± .0358 > 125 Silverblu-Aleutian (hybrid for Ambergold) mean 3.32 ± .0474. dm = .43 ± .0585. s = 7.35.

(80) *Ambergold 1955.* 158 Ambergold-Silverblu mean 2.13 ± .0205 < 157 Silverblu-Aleutian mean 2.21 ± .0298. dm = .08 ± .0298. s = 2.68.

(81) *Ambergold 1955.* 158 Ambergold-Silverblu mean 2.13 ± .0205 < 190 Silverblu (hybrid for Ambergold) mean 2.15 ± .0203. dm = .02 ± .0288. s = 0.69.

PALOMINO MALES

(82) *Palomino 1954.* 37 Palomino-Silverblu-Breath of Spring mean 3.08 ± .0332 < 184 Breath of Spring-Silverblu (carry Aleutian) mean 3.46 ± .0652. dm = .38 ± .0732. s = 5.19.

(83) *Palomino 1957.* 19 Silverblu mean 4.26 ± .0646 > 986 Silverblu-Palomino mean 3.56 ± .0204. dm = .70 ± .0325. s = 2.15.

(84) *Palomino Hybrids 1957.* 191 Silverblu mean 3.78 ± .0345 > 154 Silverblu (hybrid for Palomino) mean 3.32 ± .0424. dm = .46 ± .0546. s = 8.42.

MOYLE BUFF MALES

(85) *Moyle Buff 1954.* 25 Boyle Buff mean 4.04 ± .0164 > 56 Silverblu (hybrid for Aleutian) mean 3.35 ± .0681. dm = .69. s = 9.86.

(86) *Moyle Buff 1954.* 25 Moyle Buff mean 4.04 ± .0164 > 119 Pastel mean 3.79 ± .0511. dm = .25 ± .0536. s = 4.7.

(87) *Moyle Buff 1956.* 648 Moyle Buff mean 4.16 ± .0211 > 63 Dark (miscellaneous hybrids) mean 3.53 ± .0920. dm = .63 ± .0938. s = 6.72.

(88) *Moyle Buff 1956.* 648 Moyle Buff mean 4.16 ± .0211 > 10 Dark (wild type) mean 3.75 ± .1413. dm = .41 ± .1429. s = 2.87.

(89) *Moyle Buff 1957.* 239 Moyle Buff mean 4.43 ± .0365 > 27 Dark (wild type) mean 3.94 ± .0967. dm = .49 ± .1034. s = 4.74.

(90) *Moyle Buff 1957.* 222 Silverblu-Aleutian-Moyle Buff mean 3.88 ± .0294 > 136 Silverblu-Aleutian mean 3.75 ± .0378. dm = .13 ± .0463. s = 2.81.

MOYLE BUFF FEMALES

(91) *Moyle Buff 1954.* 48 Moyle Buff mean 2.13 ± .0412 > 49 Dark mean 1.99 ± .0272. dm = .14 ± .0494. s = 2.83.

(92) *Moyle Buff 1954.* 9 Moyle Buff mean 2.20 ± .0720 > 49 Dark mean 1.99 ± .0272. dm = .21 ± .0770. s = 2.73.

(93) *Moyle Buff 1955.* 99 Silverblu-Moyle Buff mean 2.20 ± .0283 > 196 Silverblu (hybrid for Palomino) mean 2.08 ± .0188. dm = .12 ± .0335. s = 3.58.

(94) *Moyle Buff 1956.* 64 Moyle Buff-Silverblu mean 2.15 ± .0319 < 18 Silverblu (hybrid for Moyle Buff) mean 2.15 ± .0319. dm = .12 ± .0677. s = 1.77.

HYBRID MOYLE BUFF MALES

(95) *Hybrid Moyle Buff 1954.* 49 Silverblu (hybrid for Moyle Buff) mean 3.87 ± .0804 > 56 Silverblu (hybrid for Aleutian) mean 3.35 ± .0681. dm = .52 ± .1053. s = 4.9.

(96) *Moyle Buff Hybrids 1955.* 333 Dark (wild type, carry Moyle Buff) mean 4.30 ± .0370 > 43 Dark (wild type, carry Ambergold and Silverblu) mean 3.68 ± .0745. dm = .62 ± .0745. s = 7.46.

(97) *Moyle Buff Hybrids 1955.* 65 Silverblu (hybrid for Moyle Buff) mean 4.16 ± .0649 > 154 Silverblu (hybrid for Palomino) mean 3.32 ± .0424. dm = .84 ± .0775. s = 10.85.

(98) *Moyle Buff Hybrids 1955.* 65 Silverblu (hybrid for Moyle Buff) mean 4.16 ± .0649 > 191 Silverblu (hybrid for Ambergold) mean 3.78 ± .0345. dm = .38 ± .0547. s = 6.95.

(99) *Moyle Buff Hybrids 1957.* 52 Dark (hybrid for Moyle Buff) mean 4.32 ± .0739 > 27 Dark (wild type) mean 3.94 ± .0967. dm = .38 ± .1217. s = 3.12.

(100) *Moyle Buff Hybrids 1957.* 25 Pastel (hybrid for Moyle Buff) mean 4.34 ± .0856 > 222 Pastel mean 4.17 ± .0947. dm = .17 ± .0949. s = 1.79.

(101) *Moyle Buff Hybrids 1957.* 57 Aleutian (carry Moyle Buff) mean 3.89 ± .0670 > 246 Aleutian (carry Silverblu) mean 3.71 ± .0318. dm = .18 ± .0741. s = 2.43.

(102) *Moyle Buff Hybrids 1957.* 217 Silverblu-Aleutian (hybrid for Moyle Buff) mean 3.79 ± .0319 > 47 Silverblu-Aleutian mean 3.72 ± .0824. dm = .07 ± .0883. s = 0.79.

(103) *Moyle Buff Hybrids 1957.* 217 Silverblu-Aleutian (hybrid for Moyle Buff) mean 3.79 ± .0319 > 136 Silverblu-Aleutian mean 3.75 ± .0358. dm = .04 ± .0475. s = 0.84.

(104) *Moyle Buff Hybrids 1957.* 217 Silverblu-Aleutian (hybrid for Moyle Buff) mean 3.79 ± .0319 > 125 Silverblu-Aleutian (hybrid for Ambergold) mean 3.32 ± .0474. dm = .47 ± .0571. s = 8.23.

(105) *Dark Moyle Buff Allel 1957.* 239 Moyle Buff mean 4.43 ± .0365 > 67 Dark Moyle Buff Allel mean 3.25 ± .0591. dm = 1.18 ± .0694. s = 17.00.

(106) *Hybrid Moyle Buff 1954.* 42 Silverblu (hybrid for Moyle Buff) mean 2.19 ± .0385 > 25 Silverblu (hybrid for Ambergold) mean 2.12 ± .0428. dm = .07 ± .0576. s = 1.21.

(107) *Hybrid Moyle Buff 1955.* 327 Dark (hybrid for Moyle Buff) mean 2.31 ± .0153 > 77 Dark (hybrid for Ambergold and Silverblu) mean 1.91 ± .0200. dm = .40 ± .0328. s = 12.19.

(108) *Hybrid Moyle Buff 1955.* 327 Dark (hybrid for Moyle Buff) mean 2.31 ± .0153 > 19 Aleutian (hybrid for Moyle Buff) mean 2.10 ± .0616. dm = .21 ± .0634. s = 3.31.

(109) *Hybrid Moyle Buff 1955.* 327 Dark (hybrid for Moyle Buff) 2.31 ± .0153 > 65 Dark (hybrid for Ambergold and Silverblu) mean 2.13 ± .0318. dm = .18 ± .0353. s = 5.10.

(110) *Hybrid Moyle Buff 1955.* 19 Aleutian (hybrid for Moyle Buff) mean 2.10 ± .0277 > 80 Aleutian (hybrid for Silverblu) mean 2.05 ± .0277. dm = .05 ± .0392. s = 1.27.

MISCELLANEOUS

(111) *Dark 1956.* 19 Dark mean 2.01 ± .0480 = 35 Miscellaneous hybrids mean 2.01 ± .0404.

SIGNIFICANT COMPARISONS REFERRED TO IN THE VECTOR MODELS

SILVERBLU

(a) Dark + Silverblu — 8.74% increase in males.
(b) Dark + Silverblu — 8.96% increase in females.
(c) Aleutian + Silverblu — 6.78% increase in males.
(d) Aleutian + Silverblu — 5.01% increase in females.
(e) Breath of Spring-Aleutian + Silverblu — 5.53% increase in females.
(f) Pastel + Silverblu — 5.97% increase in females.
(g) Ambergold + Silverblu — 5.44% increase in females.
(h) Silverblu + Aleutian — 5.52% decrease in females.

ALEUTIAN

(a) Dark + Aleutian — 4.23% decrease in males.
(b) Dark + Aleutian — 4.14% decrease in females.
(c) Silverblu-Ambergold + Aleutian — 8.78% decrease in males.
(d) Silverblu + Aleutian — 9.01% decrease in males.
(e) Silverblu-Aleutian vs. Silverblu-Ambergold — 4.93% difference in males.
(f) Breath of Spring + Aleutian — 7.45% decrease in males.
(g) Breath of Spring-Silverblu-Palomino vs. Breath of Spring-Aleutian — 4.55% difference in males.
(h) Moyle Buff + Aleutian — 5.58% decrease in size in males.

PASTEL

(a) Dark + Pastel — 9.05% increase in males.
(b) Dark + Pastel — 5.03% increase in females.
(c) Dark hybrid for Pastel vs. Pastel — 5.55% difference in females.
(d) Breath of Spring-Aleutian vs. Breath of Spring-Pastel — 6.84% difference in females.
(e) Breath of Spring-Silverblu vs. Breath of Spring-Pastel — 5.94% difference in males.

BREATH OF SPRING

(a) Pastel + Breath of Spring — 5.86% decrease in males.
(b) Aleutian + Breath of Spring — 2.88% decrease in males.
(c) Silverblu-Aleutian + Breath of Spring — 3.81% decrease in females.

AMBERGOLD

(a) Silverblu + Ambergold — 11.07% decrease in males.
(b) Silverblu-Aleutian + Ambergold — 11.57% decrease in males.
(c) Breath of Spring - Silverblu - Aleutian + Ambergold — 11.57% decrease in males.
(d) Silverblu-Aleutian + hybrid Ambergold — 10.72% decrease in males.
(e) Silverblu-Aleutian hybrid for Ambergold vs. Silverblu-Ambergold — 12.95% difference in males.

PALOMINO

(a) Silverblu + Palomino — 16.44% decrease in males.
(b) Breath of Spring-Silverblu + Palomino — 10.98% decrease in males.
(c) Silverblu + hybrid Palomino — 12.17% decrease in males.

MOYLE BUFF

(a) Dark + Moyle Buff — 13.40% increase in males.
(b) Dark + Moyle Buff — 8.79% increase in females.
(c) Silverblu + Moyle Buff — 20.60% increase in males.
(d) Silverblu + Moyle Buff — 5.77% increase in females.
(e) Dark Moyle Buff Allel vs. Moyle Buff — 6.94% difference in males.
(f) Dark + hybrid Moyle Buff — 9.64% increase in males.

(g) Silverblu + hybrid Moyle Buff — 12.52% increase in males.

(h) Dark hybrid for Ambergold and Silverblu + hybrid Moyle Buff — 16.85% increase in males.

(i) Silverblu hybrid for Ambergold vs. Silverblu hybrid for Moyle Buff — 3.30% difference in males.

(j) Dark hybrid for Ambergold and Silverblu vs. Dark hybrid for Moyle Buff — 8.45% difference in males.

(k) Silverblu hybrid for Palomino vs. Silverblu hybrid for Moyle Buff — 25.30% difference in males.

(l) Silverblu hybrid for Ambergold vs. Silverblu hybrid for Moyle Buff — 10.05% difference in males.

(m) Aleutian + Moyle Buff — 4.85% increase in males.

(n) Aleutian hybrid for Moyle Buff vs. Dark hybrid for Moyle Buff — 10.00% difference in females.

(o) Silverblu-Aleutian hybrid for Ambergold vs. Silverblu-Aleutian hybrid for Moyle Buff — 14.16% difference in males.

(p) Aleutian hybrid for Silverblu vs. Aleutian hybrid for Moyle Buff — 2.44% difference in males.

NEEDLE GROWTH ON PINE SEEDLINGS AS RELATED TO SIZE OF FOREST OPENINGS

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In the Piedmont, it is well known that increasing forest canopy shade becomes detrimental to survival and growth of shortleaf (*Pinus echinata* Mill) and loblolly pine (*P. taeda* L.). Brender (1) has reported that in the forest of the lower Piedmont of Georgia a relatively small amount of overwood will markedly reduce the height growth of loblolly pine seedlings, as compared to that of free-growing seedings. Oosting and Kramer (4) concluded that light was a more significantly controlling factor than soil moisture in the complex of factors that limit shortleaf pine reproduction in North Carolina. Brinkman and Swarthout (2) found in east-central Alabama that satisfactory reproduction of shortleaf and loblolly pine did not occur unless the canopy in the pine forests was at least 50 per cent open. In hardwood forests, the growth of pine reproduction became limited when the canopy was less than 75 per cent open. To get further information on the regeneration of the shade-intolerant pine species by the group selection harvest cutting method, a study was made of the relation of canopy opening size to the stem and crown growth of shortleaf and loblolly pine seedlings (3). This paper presented data on the influence of canopy opening size on the needle growth of the two pine species.

PROCEDURES

A series of circular plots with overwood opening diameter classes that increased by 10-foot intervals from 5 to 55 feet was established in a pure 55-year-old shortleaf pine forest located on Forestry School properties in Clarke County, Georgia. Each opening class was replicated 5 times. Twenty-five one-year-old seedlings of shortleaf pine and 20 of loblolly pine were planted with 2 x 2-foot spacing under the opening on each plot.

After four growing seasons, a composite sample of one-year-old needles was gathered from the seedlings on four replicates of each opening class. Each sample consisted of 30 needles randomly selected from ten average-sized seedlings. A final sample of 50 needles was randomly drawn from the composite sample. After the length measurements were made, the samples were dried to a constant weight at 105° C. Another sample of 25 needles was drawn from the composite sample and sectioned at

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This paper was presented to the Georgia Academy of Science annual meeting at Athens, Georgia, 1960.

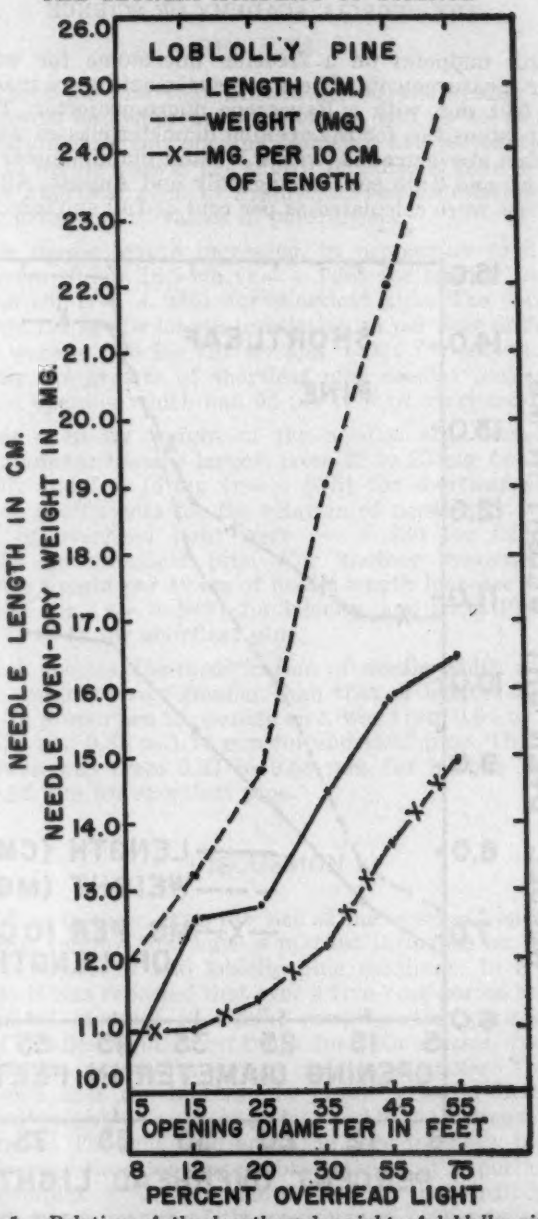

FIGURE 1. *Relation of the length and weight of loblolly pine needles to the diameter of the forest canopy opening and to the light intesity.*

the length midpoint on a freezing microtome for width and diameter measurements. These measurements were made to the nearest 0.01 mm with a Rayoscope micro-projector. The average light intensities for the opening diameter classes were taken at four feet above ground, with a Weston illuminometer between 10:00 a.m. and 2:00 p.m. during July and August. All average light values were calculated as per cent of full sunlight.

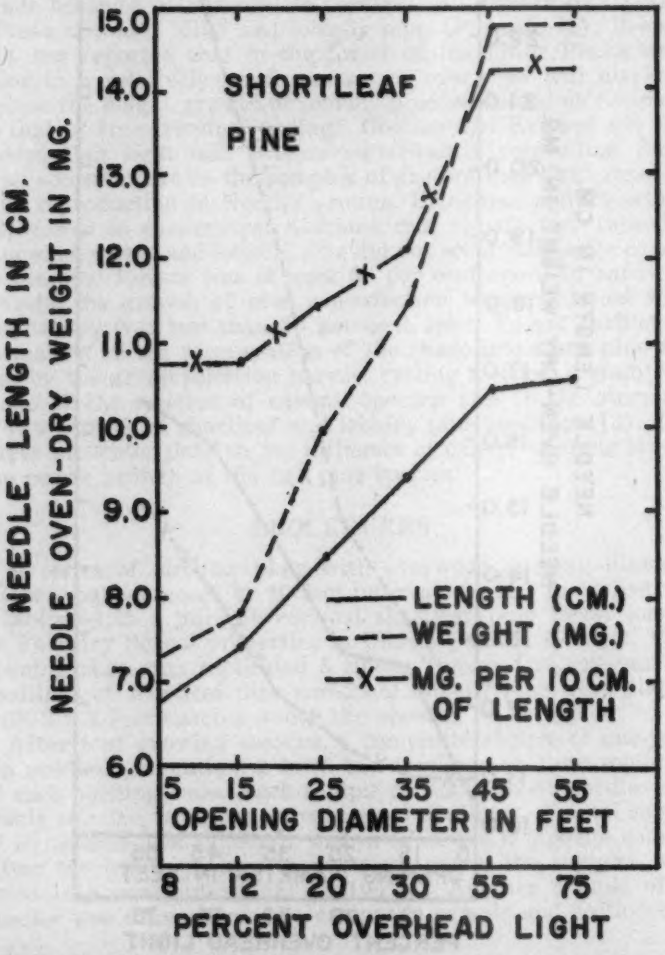

FIGURE 2. *Relation of the length and weight of shortleaf pine needles to the diameter of the forest canopy opening and to the light intensity.*

RESULTS

Throughout the four-year growth period, the needles of both species showed no symptoms of chlorosis, wilt or dieback. Data on the relation of canopy opening diameter, and per cent of light intensity to needle growth are shown for loblolly pine in Figure 1, and for shortleaf pine in Figure. 2. The correlation coefficients are given as "r" values in parenthesis.

Average needle length increased, in proportion to diameter opening from 10.7 to 16.5 cm (r= +.986) for loblolly, and from 6.8 to 10.6 cm (r= +.985) for shortleaf pine. The correlation coefficients for needle length in relation to per cent of full light intensity were +.939 for loblolly and +.924 for shortleaf pine. Apparently the growth of shortleaf pine needles peaked under the 45-foot opening which had 55 per cent of overhead light.

Average oven-dry weight of the needles also increased, as opening diameter became larger, from 12 to 25 mg (r= +.985) for loblolly and 7 to 14 mg (r= +.975) for shortleaf pine. The correlation coefficients for the relation of needle dry weight to per cent of overhead light were r= +.980 for loblolly and r= +.954 for shortleaf pine. For another measurement of growth, the weight per 10 cm of needle length increase was from 10.9 to 15.0 mg (r= +.948) for loblolly, and from 10.8 to 14.3 mg (r= +.874) for shortleaf pine.

For both species, the modification of needle width and diameter was comparatively smaller than that of length. The width increase, in proportion to opening size, was from 0.94 to 1.27 mm for loblolly and 0.88 to 1.14 mm for shortleaf pine. The increase in thickness was from 0.47 to 0.68 mm for loblolly and from 0.43 to 0.62 mm for shortleaf pine.

DISCUSSION

According to these data, the size of the overhead opening in a pine forest canopy does have a marked influence on the crown growth of shortleaf and loblolly pine seedlings. In a previous paper (3) it was reported that over a five-year period the annual increment of increase in height growth, stem diameter, and length of needle retention on twigs for both species was in proportion to the increase in canopy opening diameter. These data have shown that the increase in needle growth, in terms of length and weight, was also in proportion to the increase in opening diameter. The modification of the light intensity by the size of the opening diameter was probably the most important factor in the complex of environmental factors that influenced the stem and crown growth of the seedlings of both species.

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PSYCHOSOMATIC SYNTHESIS OF BEHAVIOR TRENDS IN THE TAMING OF MINK

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INTRODUCTION

A twelve year study* involving 108,717 ranch bred mink was undertaken in order to discover the factors determining domestication, because mink are in the process of being domesticated, a term that includes tameness and docility. Domestication implies the radical alteration, on a genetic basis, of that machinery the end-product of which is behavior. It is an assembling in individuals constellations of gene allels which, acting and interacting with each other, synthesize the kind of quiet, friendly behavior desired by man, in contrast to the wild and savage responses that adapt the animal for survival in the cruel and rigorous environment of the forest.

There is no doubt but that in the process of domestication there are involved the pleiotropic effects of certain coat color genes and that these gene-induced modifications include (1) direct gene-induced changes in morphology, physiology and psychosomatic behavior,[1] plus (2) the interaction effects produced by combinations of the same coat color genes.

Some of the influences of coat color genes upon body size and bodily proportions have been placed on record[2] already and the rest of the findings on the subject will be published in the near future. In the present paper we shall describe judgments of the relative tameness of several colorphase mink strains and then report upon the direction and degree of alteration in size of adrenals and gonads of the same strains as a psychosomatic explanation of the changes in behavior.

MATERIALS AND METHODS

More than 1,125 freshly pelted mink carcasses identified as to coat color were shipped from Suamico, Wisconsin, to Milledge-

* This study was supported by a seven-year grant-in-aid from the Rockefeller Foundation and two annual grants from the Southern Fellowships Fund. Most of the dissections were carried out in research laboratory space provided at the Milledgeville State Hospital through the courtesy of Dr. Y. H. Yarbrough, then Superintendent of the Jones Hospital Building.

ville, Georgia, in closed metal boxes (eight or twelve carcasses to a box according to sex) in large, commercial refrigerator containers supplied with dry ice. Upon arrival, the metal boxes containing mink carcasses were stored in the local abattoir at low temperature until they could be dissected. Because the carcasses were wrapped in oil paper and the lids of the metal boxes were close fitting, evaporation was not a problem.

Most of the animals came from heterogeneous litters in which several color varieties were segregated in the same litter. All new mutants brought to the ranch for propagation were crossed with the same inbred Dark strain of mink to add vigor, after which the color varieties were mixed. This procedure made for uniformity of residual hereditary backgrounds upon which are displayed the effects of each coat color gene. Because of sexual dimorphism, only females were compared with females and males with males. Because of subtle, yearly fluctuations (weather, food, contagion, selection of breeders for size, etc.) only animals of the same annual crops were compared.

After thawing out a carcass in the laboratory, its weight was recorded and its body length and tail length were determined. Then its adrenals and gonads were dissected out as carefully as possible by the senior investigator and quickly placed in ground-neck weighing bottles to prevent evaporation. The thyroid was destroyed by the method of killing, i.e., by breaking the neck, and hence could not be studied. The glands were weighed on a Christian Becker Chainomatic balance to an estimated gram to reduce error, although it was realized that errors of dissection are probably much greater than that order of accuracy. The skull, right femur, right tibia, and baccula were carefully cleaned and dried for skeletal proportion studies to be reported elsewhere.

A questionnaire was sent to fifty mink ranchers each having had ten years or more of experience with most of the varieties under investigation. They were asked to classify Pastel, Silverblu, Palomino, Ambergold, Aleutian and Sapphire color varieties of mink as to "nervousness" and "gentleness." These are ranchers' terms used to express "wildness and savageness" versus "tameness and disinclination to bite." Nervous mink are very active and alert. They tend to bite caretakers when the opportunity arises. Quiet mink are less active and less aggressive. Occasional gentle mink can be carried about with impunity.

RESULTS

An analysis of the returned questionnaires showed the following estimates of behavior, although some ranchers apparently paid no attention to the relative tameness of the several coat color strains:

Pastels are gentle, say 92% of 38 ranchers answering.
Silverblus are gentle, say 86% of 44 ranchers answering.
Palominos are gentle, say 79% of 28 ranchers answering.
Ambergolds are gentle, say 71% of 31 ranchers answering.
Aleutians are nervous, say 78% of 46 ranchers answering.
Sapphires are nervous, say 78% of 45 ranchers answering.

Sapphire is a combination homozygous for gentle Silverblu and also for nervous Aleutian, and hence nervousness is genetically epistatic to gentleness in Sapphires.

Black-eyed Whites are remarkable for their tame behavior. The ranch of Jim Moore was visited by both investigators one day after dark. Jim had bred Black-eyed White to Dark mink, the wild type. The Dark hybrids, with a white belly spot and white tail tip, he had back-crossed to Black-eyed White. The two-hundred-odd backcross offspring segregated in a 1:1 ratio of Black Hybrids to Black-eyed Whites. Everywhere in the animal shed Black-eyed Whites were sleeping in the cages. No Darks were observed, so the question was asked, "Where are the Darks?" The reply was that the odor of strangers had awakened them and that they were hiding in the nest boxes. The hundred-odd missing Dark Hybrid mink were found when all the nest boxes were opened, but not a single Black-eyed White that had taken refuge in the nest boxes was discovered. Jim picked up a sleeping Black-eyed White and shook it to awaken it. This animal was so gentle that it lay quietly on its back in his hands like a kitten. It was also noticed that Black-eyed Whites come out of their nest boxes about 4 p.m. and walk around calmly and fearlessly, whereas other varieties usually wait until nearly sundown before they become active.

Kohinur (Black Cross) and Blufrost were not widespread enough to be included in the questionnaire, but opinions were recorded by experienced caretakers at the Larry Moore Mink Ranch.

It is impossible to dissect out an adrenal or a gonad carefully and weigh it with great precision, then multiply by two to get the total weight of glandular material in the body, because the left adrenal and the left gonad average slightly larger than their corresponding organs on the right side, although weights of either side may be the larger. In a certain group of 122 male mink the right adrenals averaged .0319 gram and the left adrenals averaged .0361 gram. The difference of .0045 gram is 3.3 times as large as the standard error of the difference, which was .00136 gram and hence significant statistically. A group of 25 male mink showed the right testis to be 5% smaller than the left, but this difference was not statistically significant. Eighteen female mink showed the right adrenal to be 5% smaller than the left and the right ovary (before the first ovu-

lation) to be 9% smaller than the left, but these differences were not statistically significant for the small populations studied.

When for each individual the quotient of the total adrenal weight divided by body weight is compared, it is found that both male and female Dark mink have a significantly larger ratio than Pastel and Silverblu. This is in line with the majority opinion of ranchers, namely, that these two mutant strains are noticeably tamer than the Darks.

Adrenal weight in grams ÷ Body weight in grams

49 Dark males ratio	.0000904 ± .000002881
74 Pastel males ratio	.0000772 ± .000002042
difference =	.0000132 ± .000003531

s = 3.7

49 Dark males ratio	.0000904 ± .000002881
48 Silverblu males ratio	.0000739 ± .000002191
difference =	.0000165 ± .000003619

s = 4.5

48 Dark females ratio	.000100 ± .00000263
53 Pastel females ratio	.000079 ± .00000224
difference =	.000021 ± .00000345

s = 6.1

48 Dark females ratio	.000100 ± .00000263
50 Silverblu females ratio	.000074 ± .00000229
difference =	.000026 ± .00000348

s = 7.5

The smaller size of Pastel and Silverblu adrenals when divided by body weight as compared with Dark, conceivably may be due, at least in part, to heterogonic growth. It turns out from the investigators' study of relative body size that both Silverblu and Pastel mink tend to grow larger than Dark mink.

Now, if toward the end of the growth curve the rate of increase of size of adrenals and gonads is falling off more rapidly than the rate of increase in body size is leveling off, such correlations are exactly what are to be expected. If this were the whole story, then Pastel and Silverblu are tamer than Darks just because they grow to a larger size than Darks.

There is evidence elsewhere for such a point of view. Small dogs, Fox Terriers for example, are terrifically active as compared with giant dogs such as Pyrenees. Undoubtedly the Fox

Terrier acts as though it had more adrenal and gonad per unit of body weight. The present investigators have demonstrated just such heterogonic relationships in the development of various parts of the mink skeleton.

The possible effects of heterogonic growth on gland size may be investigated by comparing the adrenal weight divided by body weight and gonad weight divided by body weight for populations of ten months of age with populations of two years or more of age. The small amount of data available is instructive:

12 Old Albino male (adrenal) ratio	.0001225 ± .0000170
36 Young male (adrenal) ratio	.0001214 ± .0000220
difference =	.0000011 ± .0000

Thus adrenals of old albino males are slightly larger for their body size than are young male adrenals, but the difference is insignificant statistically.

12 Old Albino (testes) ratio	.0100	± .0024
36 Young Albino (testes) ratio	.0061	± .0005
difference =	.0039	± .0024

s = 1.6, which is not significant.

In this albino material the older animals actually increase their gland-to-body weight ratio, which is just opposite to the relationship that heterogonic growth could be called upon to explain, namely, greater tamness in Pastel and Silverblu.

The following data relates to Young versus Old Pastel females:

12 Old Pastel female (adrenal) ratio	.000079 ± .00000224
14 Young Pastel female (adrenal) ratio	.000091 ± .00000409
difference =	.000012 ± .00000466

s = 2.6, considered significant.

12 Old Pastel (ovaries) ratio	.000133 ± .0000447
14 Young Pastel (ovaries) ratio	.000189 ± .0000120
difference =	.000056 ± .0000463

s = 1.2, not statistically significant.

These data on Pastel females show a drop in gland-to-body ratio with age that for the adrenals is statistically significant, and hence heterogonic growth may be a factor with some gene mutations and not with others; or heterogonic growth may accompany one sex and not the other.

When the quotient of gonad weight divided by body weight for Pastel and Silverblu is compared with that for Dark, a significant difference is found between Dark males and both Pastel and Silverblu. Dark has more gonad per unit of body weight. With females the differences are in the same direction, being significant for Dark compared with Silverblu. However, for Dark compared with Pastel, the differences between the means of the two populations of ratios is just short of twice the standard error of the difference. This lack of significance is not surprising, considering the small size of the ovaries, and more data would probably make significant the difference observed.

49 Dark testes ratio	.007113 ± .0003915
74 Pastel testes ratio	.004616 ± .0002185
difference =	.002497 ± .0004483

s = 5.6

49 Dark testes ratio	.007113 ± .0003915
48 Silverblu testes ratio	.005317 ± .0002407
difference =	.001796 ± .0004596

s = 3.9

48 Dark ovaries ratio	.00146 ± .0000591
53 Pastel ovaries ratio	.00133 ± .0000447
difference =	.00013 ± .0000741

s = 1.7

48 Dark ovaries ratio	.00146 ± .0000591
50 Silverblu ovaries ratio	.00094 ± .0000409
difference =	.00052 ± .0000718

s = 7.2

The present findings tend, then, to explain the tamer nature of Pastel and Silverblu, in that in these two strains there is less adrenalin and less sex hormone per unit of body weight than in wild and savage Dark mink. Conceivably, such gland-body ratios may be modified by heterogonic growth as discussed above.

In order to eliminate any possible factor of heterogonic growth, matched populations of Dark, Silverblu, Pastel and Kohinur were selected from dissection data of males. Each animal in the Dark population was matched with an animal of Pastel, Silverblu and Kohinur of as nearly the same body length as possible. (Body length is a better index of growth than is weight, due to fluctuations with food obtained, elimination, temporary illness, etc.). However, for comparing the effect of

gland size on behavior, it is obvious that body weight is the best denominator for the index, due to fattening as maturity is approached, which fattening is greater in some strains than in others.

Thus, these four selected populations of glady-body weight ratios could be compared without involving any possible effects of heterogonic growth. For Blufront relatively few dissections were made, but it was possible to select animals having a spread of body lengths chosen to parallel that of the Dark population.

Using matched male populations, the comparisons of adrenal weight divided by body weight are listed below. Although animals were selected on the basis of body length, body weight was used for comparison because adrenalin strength should be proportional to the capacity of the blood system by which it is diluted.

s=0.9 { Dark male adrenals = .0913 ± .0044 grams
Kohimur male adrenals = .0871 ± .0019 grams } s=1.7 { s=2.5 } s=2.6
s=2.7 { Pastel male adrenals = .0821 ± .0013 grams
Blufrost male adrenals = .0780 ± .0030 grams
Silverblu male adrenals = .0768 ± .0032 grams }

Thus, there are significant correlations between the quotient of adrenal weight divided by Body weight ratios of Dark and Silverblu and Blufrost. The present data for Pastel are in the right direction and the significance is 1.7, approaching the value of 2 which is considered to be of proven significance.

Paired populations for gonad weight divided by Body weight yielded the following comparisons:

24 Dark male adrenals	.0765 ± .0037 grams
24 Aleutian male adrenals	.0716 ± .0037
difference =	.0049 ± .0052
24 Dark testes	.4921 ± .0336
24 Aleutian testes	.4692 ± .0215
difference =	.0229

When paired population comparisons for Aleutian females are compared, much the same results are obtained:

25 Aleutian female adrenals	.0542 ± .0021 grams
25 Dark female adrenals	.0408 ± .0070
difference =	.0023 ± .0044

Thus the Aleutians, generally agreed to be "nervous" mink when compared in paired populations with Darks for both males and females, show no statistically proven difference from the Darks in gland-to-body ratio.

CONCLUSIONS

As in previous behavior studies made by the senior author upon long-time tamed strains of laboratory rats, it is found that tameness and wildness in mink now in the process of domestication may be explained laregly on the basis of adrenal and gonad size relative to body size. These gland size variations are determined as pleiotropic manifestations of simply inherited coat-color mutations. Nervousness of Aleutians is epistatic to gentleness of Silverblu when both genes are combined homozygously in Sapphires.

SUMMARY

Coat color and weight data were collected on 108,717 ranch bred mink and dissections of more than 1,125 carcasses were made. Answers to a ranchers' questionnaire are reported that attest to the natural tameness of several coat color mutant strains of mink, Pastel and Silverblu being of greatest interest. The results of the questionnaire also indicate Aleutian and Sapphire to be of a wild and savage temperament.

It was found that adrenals and gonads in tame Pastels and Silverblus are relatively smaller for the size of the body than in Darks. The relative adrenal and gonad size in wild Aleutians is not statistically different from that of the Darks.

However, because the body sizes of Pastels and Silverblus average larger than those of Dark and the body sizes of Aleutians average smaller than Darks, it was thought advisable to eliminate any possible effect of heterogonic growth that might be operating undetected in any of these strains. The possibility of heterogonic growth influence was ruled out by the method of selecting for study from the data sheets paired populations of individuals, each pair having as nearly the same body weight or body length as possible. When the possible heterogonic growth factor was eliminated, the tame Pastels and Silverblus still showed relatively smaller adrenals and gonads than the Darks. The wild Aleutians, on the contrary, shower gland-body ratios for adrenals and gonads not statistically different from those of Darks.

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THE STEMMED PERENNIAL WHITE VIOLETS OF GEORGIA

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The stemmed white violets reported for Georgia are *Viola canadensis* L. and *V. striata* Aiton (Baird, 1942; Fernald, 1950; Gleason, 1952; and Small, 1933). In the University of Georgia Herbarium there are specimens of the former species from Rabun, Stephens, Towns, Union, and White Counties, all from the Blue Ridge Province, and of the latter from Clarke (where it is probably escaped), Fulton, Towns, and Walker Counties in the Piedmont, Blue Ridge, and Cumberland Plateau Provinces. Two collections from the same general locality (Pyron and McVaugh 2718, Duncan 12525 — northeast of Lafayette, Walker County, in rich deciduous woods in a region of calcareous rocks), however, seem more nearly to meet the characteristics for *V. rugulosa* Greene, another stemmed perennial white violet.

Gleason (1952) reports this species from "nw. N.C. and ne. Tenn." Fernald (1950) and Baird (1942), however, report this species no nearer than Iowa, and Russell (1958B) reports only *V. canadensis* and *V. striata* from Tennessee. This latter Walker County material, which is from the Cumberland Plateau Province, is characterized by slender, elongate (to 20 cm), subterranean stolons (diagnostic characters used by Baird, 1942; Fernald, 1950; and Russell, 1958A) and broadly cordate to reniform basal leaves (used by Russell, 1958A), whereas *V. canadensis* has thick shorter rhizomes and more narrowly cordate leaves.

The ratio of length of the leaf blade to the distance between the base of the leaf lobes was determined for the largest basal leaves of those specimens having mature leaves. The ratios for the Walker County material varied from 1.37 to 2.05, while that for the *V. canadensis* specimens was from 2.36 to 3.70 indicating numerically the broader nature of the leaves from the collections thought to be *V. rugulosa*. This difference in leaf shape is demonstrated in Figure 1 which presents a scatter diagram for the length of the leaf blade (measured from the leaf tip through the junction of petiole and blade to the line connecting the lower tips of the basal lobes) and the distance between the tips of these lobes for a collection of 19 specimens of *V. rugulosa* (18 of Duncan 12525 and one of Pyron & McVaugh 2718) from Walker County and five specimens of *V. canadensis* from Rabun (Duncan 9557), Towns (Duncan 7587), Union (Duncan 21768B), and White (Duncan 16365—2 specimens) Counties. Seed size was intermediate to that given for the two species by Fernald (1950). According to data from specimens in the University of Georgia Herbarium, *V. canadensis* is in flower in Georgia from 16 April through 28 May and *V. rugulosa* from 24 April through 20 May.

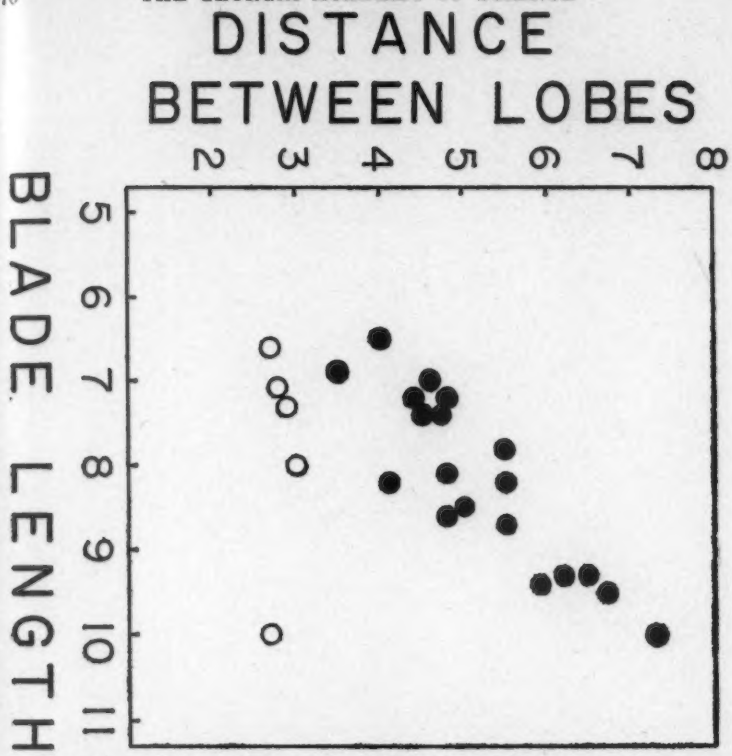

FIGURE 1. *Scatter diagram for leaf measurements in centimeters of specimens of Viola rugulosa (dots) and V. canadensis (circles) from Georgia. Further explanation in the text.*

According to Russell (1958A) *V. rugulosa* and *V. canadensis* intergrade and may not be distinct species. Until this question is answered, however, *V. rugulosa* should be added to the flora of Georgia, since here the two seem distinguishable. Should *V. rugulosa* turn out to be only a subspecies or variety of *V. canadensis*, the taxon apparently would still be represented in Georgia.

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